T.C.
ISTANBUL GEDİK UNIVERSITY
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EVALUATION OF IMPORTANT FACTORS AFFECT ON MANAGEMENT OF HIGHWAY PROJECTS

MASTER'S THESIS

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Civil Engineering Department

Master in Civil Engineering English Program

JULY 2023

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Thesis Advisor: Assoc. Prof. Dr. Redvan GHASEMLOUNIA

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İSTANBUL GEDİK ÜNİVERSİTESİ
LİSANSÜSTÜ EĞİTİM ENSTİTÜSÜ MÜDÜRLÜĞÜ

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Enstitümüz, Civil Management Department İngilizce Tezli Yüksek Lisans Programı (211291005) numaralı öğrencisi Manar Mahmood Ali AL-GHRAIRI'nin "Evaluation of Important Factors Effect on Management of Highway Projects" adlı tez çalışması Enstitümüz Yönetim Kurulunun 20/07/2023 tarihinde oluşturulan jüri tarafından *Oy Birliği* ile Yüksek Lisans tezi olarak *Kabul* edilmiştir.

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DECLARATION

I Manar Mahmood Ali AL-GHRAIRI as a result of this declare that this thesis titled “Evaluation of Important Factors Effect on Management of Highway Projects” is original work I did for the award of the master's degree in the faculty of Civil Engineering Program I also declare that this thesis or any part of it has not been submitted and presented for any other degree or research paper in any other university or institution. (20/07/2023)

Manar Mahmood Ali AL-GHRAIRI

DEDICATION

This study is wholeheartedly committed to my adorable dad and mom, for have been our deliver of nation and gave us energy at the same time as we idea of giving up, who usually offer their ethical, secular, sentimental, and monetary guide. To my sisters, who have been my beneficial resource whenever. And finally, we committed thesis to my lord, thanks for the guidance, energy, of the mind, protection and capabilities and for giving us a healthful existence.

PREFACE

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July 2023 Manar Mahmood Ali AL-GHRAIRI

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ABBREVIATIONS

AASHT	: American Association of State Highway and Transportation Officials
ARs	: Assess Risks
AT	: Alpha Test
BOT	: Built Operate and Transfer
CRs	: Construction Risks
DBFOT	: Design Build Finance Operate and Transfer
ERs	: Environmental Risks
EU	: European Union
GD	: Geometric Design
HNs	: Highway Networks
HP	: Highway Project
HPP	: Highway Project Planning
II	: Iraq's Infrastructure
IRs	: Identify Risks
KBD	: Kut-Badra-Mahran
KMO	: Kaiser-Meyer-Olkin Measure
KRG	: Kurdistan Regional Government
MOCH	: Ministry of Works and Housing
MR	: Maintenance Risks
NB	: Northbound
PCI	: Pavement Quality Index
PCM	: Project Cost Management
PD	: Pavement Design
PE	: Project Equipment
PF	: Project Funds
PM	: Project Managers
PPP	: Public-Private Partnerships
PQC	: Project Quality Control
PS	: Project Strategy
PTI	: Project Technological Innovation
RCPs	: Roads Construction Projects
RM	: Risk Management
RMP	: Risk Management Plan
RSs	: Monitor Risks
SB	: Southbound
SPSS	: Statistical Package for the Social Sciences

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EVALUATION OF IMPORTANT FACTORS AFFECT ON MANAGEMENT OF HIGHWAY PROJECTS

ABSTRACT

Professionals in different fields of construction often need to pool their resources and skills while working together on a project. It is also important to carefully alert prospective clients, consultants, and contractors to such details. The construction industry as a whole may be negatively impacted by poor communication in a number of ways. It may endanger the project's timeline, money, legalities, quality, and even the safety of its participants. The process of analyzing the data and rating them. When evaluating the different reasons for the delay, significance scales with five points were used. For the pilot testing, a total of twenty people from each of the four groups were selected, and the reliability of the instruments was determined using Cronbach's alpha. The inquiry was factor analyzed so that it could be more efficiently organized, and the variables could be categorized into meaningful categories. The customer, the consultant, and the contractor each participated in their own separate stages of the analysis. The KMO and Bartlett tests were performed to determine whether or not there was a sufficient number of samples, and the findings indicate that the variables exhibit interdependence and correlation, which is a prerequisite for conducting factor analysis. A multiple regression analysis has been carried out so that the one-of-a-kind impact of the lag caused by PCFA variables may be quantified. In the case of regression analysis, the coefficient represents the proportional alteration in the dependent variable that takes place with each unitary modification within the independent variables.

Keywords: *Highway, Construction, Project Management, Road Management*

KARAYOLU PROJELERİNİN YÖNETİMİNE ETKİSİ OLAN ÖNEMLİ FAKTÖRLERİN DEĞERLENDİRİLMESİ VAKA

ÖZET

İnşaatın farklı alanlarındaki profesyoneller, bir proje üzerinde birlikte çalışırken genellikle kaynaklarını ve becerilerini bir araya getirme ihtiyacı duyarlar. Potansiyel müşterileri, danışmanları ve yüklenicileri bu tür ayrıntılar konusunda dikkatli bir şekilde uyarmak da önemlidir. Bir bütün olarak inşaat sektörü, zayıf iletişimden çeşitli şekillerde olumsuz etkilenebilir. Projenin zaman çizelgesini, parasını, yasallığını, kalitesini ve hatta katılımcılarının güvenliğini tehlikeye atabilir. Verileri analiz etme ve derecelendirme süreci. Gecikmenin farklı nedenleri değerlendirilirken beşli önem dereceleri kullanılmıştır. Pilot uygulama için dört grubun her birinden toplam yirmi kişi seçildi ve araçların güvenilirliği Cronbach alfa kullanılarak belirlendi. Soruşturma, daha verimli bir şekilde organize edilebilmesi ve değişkenlerin anlamlı kategoriler halinde kategorize edilebilmesi için faktör analizine tabi tutulmuştur. Müşteri, danışman ve yüklenicinin her biri, analizin kendi ayrı aşamalarına katıldı. Yeterli örneklem sayısının olup olmadığını belirlemek için KMO ve Bartlett testleri yapılmış ve bulgular faktör analizi yapabilmek için ön koşul olan değişkenlerin karşılıklı bağımlılık ve korelasyon sergilediğini göstermektedir. PCFA değişkenlerinin neden olduğu gecikmenin türünün tek örneği etkisinin ölçülebilmesi için çoklu bir regresyon analizi yapılmıştır. Regresyon analizi durumunda, katsayı, bağımlı değişkende, bağımsız değişkenler içindeki her üniter değişiklikle meydana gelen orantılı değişimi temsil eder.

Anahtar Kelimeler: *Otoyol, İnşaat, Proje Yönetimi, Yol Yönetimi*

1. INTRODUCTION

1.1 Overview

Motorways are large public roads that connect large population centers. Highways make it possible to quickly transport people and products according to regional needs, which is why they play such a central role in the country's growth [1, 2]. One of the most popular modes of transportation is the highway. When other modes of transportation are impractical due to environmental factors, this becomes crucial. Road infrastructure projects are notoriously difficult and risky due to high upfront costs and potential returns. Motorway offers integration worldwide, but it must also meet the demands of the global world as a growing sector in the context of providing interaction. Highway construction is widely regarded as a high-risk construction undertaking owing to its significance in fostering political, and economic growth within a nation [3]. The success of these projects is contingent upon meeting predetermined timelines, adhering to financial constraints, and minimizing environmental impact, despite any outward indications to the contrary [4]. Highway projects are acknowledged by governments as crucial and are being actively pursued to ensure their timely completion. Overruns and delays in costs can have a detrimental impact on the growth of the economy. Therefore, highway projects must adhere to these standards to be successful. Although essential to project success, many variables such as unresolved project financing, poor project planning, and construction errors can slow down highway projects [5]. Several countries, including Egypt, Cambodia, and Kenya, are presently undergoing research to determine the crucial factors that impact their highway development initiatives [6-8]. However, such details are lacking in the existing construction literature. If so, highway business scholars and practitioners can benefit from a deeper understanding of the variables that affect local road projects. Especially if significant problems can be overcome, road construction can prevent complications and unwanted disasters. Highways, which account for 95 percent of all freight and passenger traffic, are constantly being

modernized and expanded, and have become one of the industry's most profitable assets. The persistent increase in the global population, coupled with the advancement of technology and manufacturing, has resulted in a surge in the demand for essential commodities and an ongoing depletion of earth's resources [9-15]. The study of the most efficient use of limited resources is becoming popular and important. Free and open to the public highway, land and all associated bridges and facilities. Another definition of highway [15-19]. Built Operate and Transfer (BOT) and Design Build Finance Operate and Transfer (DBFOT) are two of the most common PPP options currently used by the government to complete national road construction projects [20]. Buildings and infrastructure are essential to the effectiveness and efficiency of national production. The speed of road construction in the current economic period is 27 kilometers per day, while in the previous economic period it was 30 kilometers per day due to the decline in economic activity. As a result, the government has lowered its road construction target to 6,000 kilometers for the current fiscal year. According to Lei gland, the interest of the private sector in public-private partnerships (PPP) has significantly decreased since 2012 [21]. PPP contracts are agreements between a private company and a public authority for the joint financing, construction and implementation of an infrastructure project. Disagreements mostly arise due to cost overruns, lawsuits and compensation settlements [22]. This is because incorrect information is not easily seen, which in turn leads to lower profit margins and lower productivity [23]. Therefore, highway construction projects are prone to many problems that cause delays, such as construction site contamination, supplier bankruptcy, logistics failures, and community resistance [25]. The deficiency of openness and data sharing in this domain has also had an impact on productivity [26, 27]. According to the study's authors, time and cost overruns have led to poor performance of highway projects over the past three decades. It is imperative to identify the issues that impact the development of the roadway.

Need for Highway construction Management

Road construction has been shown to increase both social and economic activity in the region. Because of these considerations, road networks should be preferred over all others. The value of the European road system is more than 8 trillion euros [28] and there are 5.5 million kilometers of roads. However, the condition of these roads is affected by use and age. What seems good at first glance can hide serious problems. It requires maintenance, renovation and updating. Research shows that properties care is critical to maintaining and maximizing these benefits. However, the road system deteriorated beyond repair due to maintenance that was left unfinished. If not properly maintained, they may need to be replaced or repaired within a few years. When such wear and tear increase throughout the road network, it raises prices and has far-reaching consequences for the economy and the standard of living of the population. Hence, it is imperative for decision-makers to comprehend the significance of providing care. However, this is rarely acknowledged and poor asset management is a major factor in the poor state of many EU road networks. Different governments can implement it. At the same time, the Vision Zero strategy was implemented to improve road safety. The EU has set new targets to reduce road deaths and the ultimate goal is to have no deaths on EU roads by 2050 [28].

Global Context

Several research studies have been conducted to ascertain the factors that impact the standard of construction projects. Ahmed et al. report that construction project delays are the most common, costly, challenging, and harmful [53]. The delay surpasses the contract completion deadline or project delivery date. Assaf, Al-Hejji [54]. Each study found and emphasized distinct factors. Figure 1.1 classifies building study reasons. Construction delays vary by building type, from 113 in Malaysia to 7 in Hong Kong [55]. The research primarily focused on investigating the factors that cause delays in general construction projects. Additionally, four studies were conducted to explore the factors affecting building construction projects in various countries, while two studies were conducted to examine the development of pipeline projects in different countries. Lastly, a single study was conducted to investigate the development of roads in Palestine. The objective of these studies is to broaden the

scope of research on road projects, given that the prompt construction of highways is a matter of great national importance. Initially, it is advisable to acquire fundamental knowledge and identify any existing issues.Menesi [56] divides delay into three categories: (1) Excusable delays are categorized into further subtypes. (a) Compensable (Owner) and (b) non-Compensable; (2) Inexcusable delays; and (3) Concurrent delays. 12 approved projects (8 contractors and 6 consultants) were selected for site inspection. On-site interviews were scheduled and unplanned. Thirty persons were interviewed, 2.5 per project. The data was compared to comparable polls in developing economies. The results of the study provide evidence to corroborate the notion that the challenges faced by the construction industry in developing countries can be classified into three distinct categories (a) industry infrastructure issues (primarily resource supply); (b) client and consultant issues; and (c) contractor issues. According to Kraiem and Diekmann [58], both owners and contractors care about construction project completion time. Construction delays are common. Various delays may arise due to the actions of the owner (resulting in compensable delay), the contractor (resulting in non-excusable delay), God, or a third party (resulting in excusable delay).

Odeh and Battaineh [59] identified 28 causes of delay in conventional contracts in Jordan by surveying contractors and consultants about construction delay factors. Subsequently, the survey was distributed via email to a representative subset of Jordanian consultants and contractors who are engaged in the execution of extensive construction undertakings. Spearman’s rank correlation connected contractor and consultant ratings. The research indicated that labor productivity was the biggest delay issue, followed by Owner involvement, inadequate contractor expertise, finance and payments, sluggish decision making, inappropriate planning, and subcontractors. The contractor's inexperience was the main reason of the delay, experts said. Abdul-Rahman et al. [61] noted that a successful economy requires excellent construction delay management. This study sought to identify local construction industry management methods that decrease delays. Its secondary goal is to identify project delays and provide ideas to get things moving again. They underlined the need for more experienced and competent construction managers and workers to accelerate national and global construction growth. Toor and Ogunlana [62] employed a combination of interviews and questionnaires to ascertain the

primary factors contributing to the delay of a major construction project in Thailand. Architects, builders, and consultants caused the greatest anguish. In the interviews, issues including lack of funding, poor contractor management, personnel shortages, late design beginnings, poor planning and scheduling, last-minute order modifications, and contractor financial challenges were discussed. Anastasopoulos et al. [63] used 1722 Indian highway projects to create random-parameter statistical models to predict construction delays and their duration. The model estimate shows that project cost (contract bid amount), project type, projected project length, and weather risk all affect project scheduling delays. Al-Kharashi and Skitmore revealed [64] new Saudi Arabian study that integrates all previously utilized parameters and examines both the current degree to which each variable influences delay and how it might be improved. Client, Materials, Consultant, Contract, Labor, and Relationship Causes hold these components. The survey includes 86 Saudi construction consumers, contractors, and consultants. The analysis found that a lack of trained and experienced workers is the biggest delay due to the large number of innovative construction projects ongoing and the accompanying labor shortage.

Soliman [65] conducted a study aimed at identifying the root causes of delays in Kuwaiti building initiatives. The study built on previous research and identified 29 causes of delays, which were categorized into six groups. To gather data, a questionnaire survey was administered to 30 participants, comprising 16 consultants, 9 contractors, and 5 owners. Following the analysis of the significance index, Spearman's ranking correlation coefficient was computed to quantify the level of concordance between the rankings of two given entities. Budget and design are the biggest delays, according to the statistics. Consultant document submission delays, owner payment delays, contractor-consultant disagreements, owner representative mismanagement, and owner financial worries were the top five contractor-related delays. The consultant's top five delays include owner financial difficulties, contractor financial issues, contractor personnel inefficiency, contractor-consultant conflict, and lack of project preparedness. Yang and Wei [66] administered an organized survey to engineers employed at A/E businesses involved in public building initiatives in Taiwan. The questionnaire yielded 95 valid responses, which were analysed to identify 15 delays during the planning phase and 20 delays during the design phase. This study used the Relative Relevance Index to rank reasons by

relevance and frequency of delays, then used a Likert scale questionnaire to calculate severity. Client-requested alterations waste the greatest time during planning and design. Orangi et al. [67] listed the 15 most frequent pipeline project delays in Victoria, Australia. Hasseb et al. [68] detected 37 construction delays in Pakistan using a thorough literature review. 120 government, commercial, and semi-government institutions responded to 200 questions. Some organizations had employees or private companies conduct oral interviews. Delay factors can be analysed using the mode, critical index, and variation in the mean delay factor. The research found that project delays are most often caused by the client, who must have strong financial competence and the ability to make timely, precise judgments. Kazaz et al. [69] examined Turkish construction industry time prolongation factors and importance. 34 factors affected project duration. 71 Turkish construction enterprises were given a questionnaire on the same topic, and the answers were statistically examined. The most troublesome factors were delays in payments and cash flow worries, which were followed by changes in design and materials. Hamzah et al. [70] found global causes of Malaysia's construction industry delays. The field research included experienced Malaysian developers, consultants, and contractors. 24 of 34 construction delays were picked. This research will inform future Malaysian university studies on construction industry delays. Magdy et al. [71] examined construction project delays to determine how well-known each CPM DAM is in the Egyptian construction sector, how frequently it is used, what information it needs, how hard it is to apply, and how often it works. This research triangulated quantitative questionnaire and qualitative interview data. After analyzing market mix and company numbers, questionnaires were issued. Through extensive literature reviews, Niazai and Gidado [72] analysed and classified 83 delay reasons impacting the Afghan building sector into nine groups. The questionnaires were then created and distributed to sixty carefully selected Afghan construction industry players, comprising twenty-five contractors, fifteen consultants, and twenty clients. The significance index was used to examine data, and Spearman's rank correlation coefficients were calculated for each party's hypothesis on delay reasons to assess agreement. Security concerns, corruption, poorly qualified technical staff, tardy client payments, and insufficient site management and oversight are the main reasons of construction delays in Afghanistan, according to research. Participants in the

survey agreed that delays occur in projects in Afghanistan when the contract duration is less than 12 months, with the most common delays occurring between one and six months.

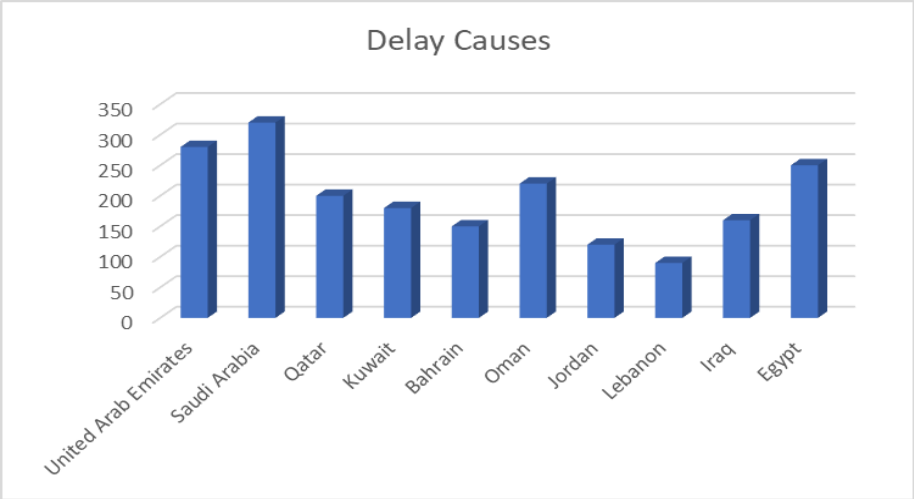

Figure 1.1: Research Findings Categorized By the Total Number of Delay Causes

1.2 Factors Affecting Highway Projects

Construction project management scholars and highway transportation experts have both studied and worked on highway project-related research questions. The primary reasons that keep coming up in their local highway projects have been identified via studies [75,76]. Late client payments, delayed client organization decision making and bureaucracy, poor planning and scheduling, and weather are among the most significant challenges facing highway construction in Kenya [75]. Top reasons in Egypt [6] include political instability, the West Bank's fragmentation, which restricts travel between different parts of the country, owners' tendency to give projects to the lowest bidders, owners' delays in making progress payments, and a dearth of necessary equipment. Cambodian highway construction is most impacted by weather, flooding, acquiring property, owners selecting the lowest bidder, and mechanical failures [76].

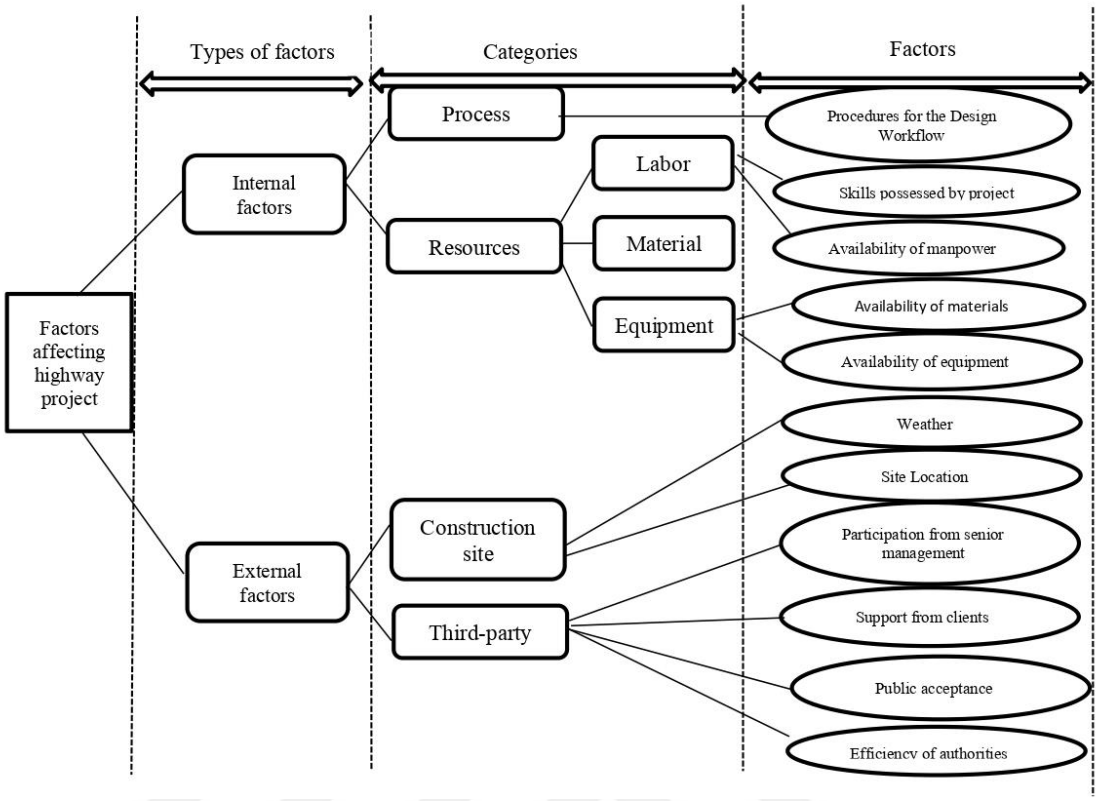

Figure 1.2: A Summary of the Factors Influencing Highway Project Success

In other words, the findings show that a variety of external variables, not only those impacting highway projects, are having an impact on the local construction industry. That's why it's crucial to look into the issues that are impacting highway construction in your area. The elements that determine the success of highway construction are summed up in Figure 1.2 The aspects are classified as external or internal from the perspective of the project manager. In other words, project managers may often take steps to address issues like inadequate equipment availability by adjusting internal factors, such as those within their control. On the other hand, external issues are those outside the purview of the project management team (such as customers who are late making progress payments).

Process, labor, material, and equipment variables make up the internal factors, while construction site and third-party variables make up the exterior elements. The following sections elaborate on each of these factors.

1.2.1 Internal factors affecting highway projects

The following are the effects of internal variables on highway construction projects:

Example: design processes. Some participants say incomplete, incorrect, or incomplete drawings might delay project implementation by resulting in unfinished construction documents. Poor documentation, project planning issues, and document evaluation time may idle contractors and their project teams. Participants said effective workflow is crucial for minimizing disruptions as highway project plans change over time. Well-organized workflows may reduce human design errors.

Internal labor: This study analyzes project management skills and workforce availability internal human concerns. Participants said highway building projects need good project management. Project managers must plan and coordinate projects, manage huge teams, and work with individuals of different personalities and skill sets. Project managers require highway construction knowledge, but most of their abilities are soft skills like analytical and problem-solving, cooperation, communication, and planning and organizing [77]. This data illustrates that highway project managers' abilities affect results. The project's success may depend on having enough staff.

Locals don't want to work on highway projects since construction is dirty, dangerous, and hard. Due to rigorous government requirements, employing international workers may be challenging. Thus, roadway projects, especially large ones, are hard to staff. Despite the labor shortage, highway projects are having problems hiring workers with the right skills, knowledge, and competences. Highway construction staff recruitment is challenging.

Second, material availability during construction is a factor. For several reasons, highway projects are expected to have trouble getting supplies on schedule, even if they should be accessible before work starts. These include a lack of local supplies, suppliers' inability to provide owing to resource shortages, unfair pricing due to monopolizing activities, and a lack of ground transportation to transfer goods to the site.

Due to currency changes, international sourcing is riskier for projects. Equipment and machinery availability are similar to materials-related internal issues. While equipment will go down, project managers can keep everything operating well by doing regular maintenance and monitoring everything [78]. Several people have suggested that the project may have inadequate machinery or tools and equipment malfunctions. To improve highway project success, project managers need a trustworthy equipment management system.

1.2.2 External factors affecting highway projects

The following factors will determine how much of impact external factors have on highway construction projects:

a. Construction-site related external factors:

According to a study of in-depth interviews with highway project managers, environmental elements like weather and site location may make or break the outcome of a construction project. To begin, rain has a greater impact on highway projects than construction projects, and not only because it dampens morale and slows down the workers. Highway projects are more vulnerable to the effects of precipitation. Previous studies, like the study on the causes of highway construction delays [79], indicate that the weather has a significant impact on the effectiveness of highway construction projects. The next thing that people have said is that site location may have a big impact on how quickly highway projects are done. When it comes to earth movement and avoiding drainage concerns, highway projects in places that are difficult for building, such steep or rocky terrains, are more demanding than those with usual terrains. Forested or marshy places are also more difficult to reach. Bridge construction presents an additional difficulty for motorways that must over waterways such as rivers or lakes. These issues are often associated with highway construction in more rural areas, but they also arise on urban construction sites [77, 80-82] when permits must be obtained from local authorities, traffic must be managed, underground utilities and services must be relocated, and temporary storage facilities must be established. Moreover, irrespective of whether the endeavour is situated in a rural or urban area, the distance among sites and the nearest quarry may impact It is success due to accessibility and cost-related issues.

As a result, site location may have a wide range of effects on highway projects, including the difficulties that arise from varying site conditions due to insufficient site study [79].

b. Third party-related external factors:

High-level management, customers, the general public, and regulatory agencies are all mentioned as potential external factors influencing the outcome of highway construction. Financial assistance (i.e., ensuring undertakings have sufficient cash before receiving funds from advancement payments) and emotional support (i.e., Senior executives engage in site visits to provide constructive feedback and inspire members of the project team) may have an important impact on the project's outcome. Management may also help projects succeed by ensuring they have enough workers with the right capabilities. One way to do this is to designate persons to be "responsible" for determining where the project team members' skill sets are lacking. On the other side, customers, who are only peripherally engaged in the projects, may help by making timely progress payments and offering constructive feedback that helps keep the project crew from becoming overburdened. On the other hand, the public and other stakeholders can have an impact on highway projects through factors like varying political opinions, inconsistent compensation amounts, land acquisition disputes, and official complaints about traffic congestion. Because of these difficulties, work may stall until they are fixed. As a result of traffic difficulties, safety challenges, and public image, numerous participants have suggested that highway projects incorporate creating alternate routes and operating throughout the night. And because of the length of time, it takes for authorities to evaluate submittals, it is speculated that they, too, have some say in whether or not highway projects are ultimately successful. Highway projects may experience challenges including idling and needless rescheduling if processing times are unpredictable and slower than normal. That is to say, popular support and competent administration are also influencing the outcome of highway projects [77].

1.2.3 Required skills for highway road projects

The Highway Engineering intends to solve the industry's skill gaps and achieve its goals: The following is a list of some of the skills which would be beneficial to firms that construct highways:

Knowledge of Road Design (Pavement Design (PD) and Geometric Design (GD))

i. Proficiency in reading comprehension and knowledge of pavement and geometric design are essential attributes for a proficient road project manager. In the event of any discrepancies in the construction plans, it is advisable for the road project manager to initiate communication with the roadway design engineer to engage in a comprehensive discussion and collaboratively devise a viable resolution [83].

ii. Super-visional Experience in Road Construction: Experience is best understood as the accumulation of knowledge and competence via actual application. It's used as a yardstick of sorts to evaluate competence in the field of engineering. The implementation of this notion may also prove advantageous for the road project manager, as it allows for the acquisition of knowledge and experience regarding the benefits and drawbacks of different methodologies, as well as their respective effects.

iii. An understanding of the American Association of State Highway and Transportation Officials' (AASHTO) standards and recommendations. When it comes to road building, the American Association of State Highway and Transportation Officials (AASHTO) has criteria for everything from road and pavement design to soil inquiry and testing using its own "AASHTO Soil Classification System." Hence, possessing a comprehensive comprehension of AASHTO's suggestions and seeking their guidance in cases of ambiguity concerning the proposed techniques or implementations is of the utmost significance for the manager overseeing the road project [83].

1.2.4 Conceptual framework for completion of highway road projects

The framework is conceptualized as a composite function, with the functions of identifying measures taken in road building projects, establishing the interrelationships of the causes, and determining the moderating impact of the road construction project parameters.

a. Capability: A person's competence is measured by how well they carry out certain tasks. Competencies allow for the systematic identification, assessment, and development of desirable work-related behaviors in individuals [84]. Competencies are also required for individuals to be productive at work. Workplace skills and duties are two different things. Competencies include everything an employee needs to do their work successfully. These situation-specific traits are associated with high-quality work and may serve as a yardstick by which to evaluate individuals' progress in their roles and as criteria for hiring and promotion. Competencies allow businesses to specify, in behavioral terms, the actions required of employees to bring about the outcomes they want, in a manner that is consistent with the values of the company as a whole. When a business clearly defines its core competencies, its staff members have the information they need to do their jobs effectively. When skills are clearly defined, they enable employers to assess whether or not their staff members are exhibiting desirable behaviors and, if not, why not. Employees may acquire the knowledge and skills they are missing. Consequently, enterprises will possess an enhanced comprehension of the resources that need to be allocated towards the training and education of their employees to attain the intended outcomes. Competencies are a great way to set yourself apart from the competition. Management techniques may be integrated throughout the business with the use of a competency-based framework. Skills that ensure the company's emphasis on desired behaviours is reflected in its hiring, performance evaluation, staff development, and compensation policies.

b. Project funding: The term "funding" denotes the provision of financial resources by an organization or government, which may take the form of monetary assistance or other valuable contributions such as labor or time, to facilitate the sustenance of a requirement, program, or undertaking. When a company utilizes its own cash on hand to meet its short-term liquidity needs, it is said to be "self-financing," as opposed to "self-financing" when it raises money from outside investors [86]. In the scenario of a margin account held at a brokerage firm that has outstanding margin loans, the term "available funds" can additionally refer to funds that are eligible for withdrawal. Tools, machinery, and whatever else could be required for a project are collectively referred to as "equipment." Business assets are any physical items not considered to be land or buildings. Devices, machinery, tools, and vehicles are all

examples of equipment [87]. According to Krazner (2005), construction equipment consists of "heavy machinery" that has been modified for specific construction functions, most often earthmoving. This category of machinery is known by various alternative designations, such as heavy machinery, heavy hydraulics, construction equipment, heavy trucks, heavy vehicles, and engineering equipment.The five standard equipment systems that are commonly found include Implementation, Structure, Traction, Control, Power Train, and Information. The operational functionality of heavy machinery necessitates the amplification of the output force exerted in relation to the input force applied, which is commonly referred to as mechanical advantage. Hydraulic drives are utilized by various machines to produce motion [88].

c. Innovating Through Technological Projects: Technology is the body of knowledge and its application in the creation of products and services and the attainment of goals like scientific inquiry. Machines, computers, gadgets, and factories are all examples of technological advancements that don't need their operators to have an in-depth understanding of the underlying mechanisms. The impact of technology is far-reaching. Technology has contributed to the growth of more developed economies (including the global economy today) and the establishment of a leisure class [89]. New technologies often give rise to novel ethical concerns, and their many applications affect a society's values. Several instances involve the interrogation of established norms and the broadening of the notion of efficacy to encompass human productivity, which was previously restricted to machines. An innovation is a new and better method, product, or concept. Innovation can be defined as the act of bringing forth superior goods or services to the market in reaction to unfulfilled demands. This is achieved by the widespread availability of more efficient commodities, procedures, services, technology, and ideas in the commercial, governmental, and social spheres. When something new and different (and hence more effective) "breaks into" the market or society, we say that it is innovative.

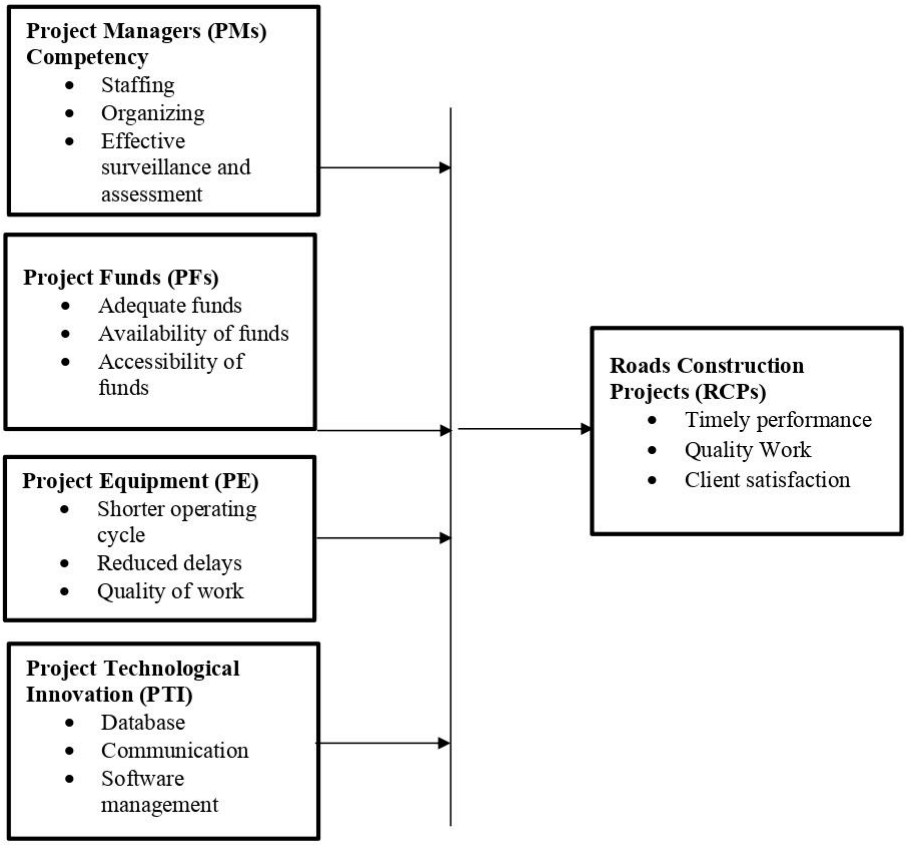

Figure 1.3: Conceptual Plan for Completing Highway Road Construction Projects

1.3 Project Management in Highway Construction

The administration of a project from its inception to its conclusion is known to as "Project Management."A project is described by Cleland et al. (2002) as "a combination of organizational resources pulled together to create something that did not previously exist and that will provide a performance capability in the design and execution of organizational strategies" [90]. The process of managing a project from start to finish is known as project management. There are deliverables in every project. Deliverables are "something of value generated by a project management team in accordance with the schedule, to be offered to an authorizing party, a reviewing committee, client constituent, or other concerned party," as defined by Davidson (2000) [91].Highway road management is responsible for organizing, managing, and classifying, and the resources required to carry out a road project's goals and objectives and guarantee user safety. The road project manager is the one whose expertise will be put to use throughout the paving process. His or her tasks will determine whether or not the project is finished on time and successfully

satisfies all requirements [92].For highway engineering projects to go off without a hitch during construction enterprises need to make sure they have solid construction management in place. This is not only important for ensuring the smooth construction of engineering projects, but also for lowering overhead and bolstering construction businesses' core competitiveness. The most fundamental criteria for fostering quick highway development are the implementation of project management and the improvement of quality awareness [92]. Therefore, it is of critical importance nowadays to study how to effectively manage the construction of highway projects and guarantee that they are finished on schedule and to specifications in terms of both quality and quantity. Highway engineering construction projects are unique endeavors distinguished by massive size, a wide variety of variables, abundant cash flow among construction firms, and intense rivalry. Due to these reasons, project management needs to be improved so that highway building companies may plan their projects in accordance with professional guidelines for project management. Gather the necessary personnel, form the building crew, and plan the process of putting the project into action. Likewise, we need to make sure that all of the project's moving parts—timeline, quality, labour, equipment, materials, cost, safety, environment, data, completion acceptance, etc.—are well-controlled and coordinated with one another.

1.3.1 Need and objectives of project management

The traditional responsibility of road administration is to maximize the quality of road maintenance within the constraints of available funds. The road administration is equipped to handle this responsibility by dividing it up into divisions staffed by experts in several fields related to road maintenance [93]. Specific responsibilities, such as road condition assessment and priority setting, acquisition of technical standards and project procurement, procurement of labor and maintenance, and financial planning, have been assigned to each department. As a result, experts in a certain field might get experience working on a wide variety of projects. Successful maintenance work planning and execution at stable funding and project type are guaranteed by this method. The public has new expectations for roads all the time because of how quickly the globe and our area are evolving. Both the volume and composition of traffic shift significantly. Because of political and economic shifts,

once-important routes have lost their significance, while traffic on previously unimportant roadways has increased. Vehicle technological specifications are evolving, traffic is becoming more dynamic, and vehicle payloads are expanding. The current road system does not meet public requirements, hence substantial rebuilding works must be carried out in place of routine maintenance. Here are some key objectives of project management [94]:

i. **Providing guidance and supervision to team members:** Teams working on a project may require supervision to accomplish tasks, change strategy or maintain quality. Project management ensures a structure of hierarchy and accountability that facilitates guidance and support to all team members.

ii. **Facilitating communication and collaboration:** The attainment of any project or team depends on clear communication and effective teamwork. Regular meetings, talks, client approvals, feedback sessions, and idea sharing help project management guarantee that everyone is working toward the same objectives without wasting time or effort.

iii. **Following all safety processes and protocols:** Certain projects, like that in food production plants or at construction sites, may require stringent adherence to strict safety protocols and processes. Project management accounts for such reviews and safety checks to ensure the quality and safety of the team members and the end product.

iv. **Reviewing and course-correcting timely:** All projects and plans require updates and changes during the implementation phase. Project management help ensure that there are assessments, quality checks and reviews throughout the project implementation so that changes can take place quickly, effectively and without disruption.

There is always an end point or target in sight for a project. There are a number of procedures and criteria that must be in place before we can reach our goal. A great deal of planning and optimization is going to be necessary to achieve the desired outcome on time, within budget, and with the agreed-upon minimum of social and environmental impact. Therefore, project administration is crucial. Figure 1.4 depicts the typical design and upkeep project life cycle.

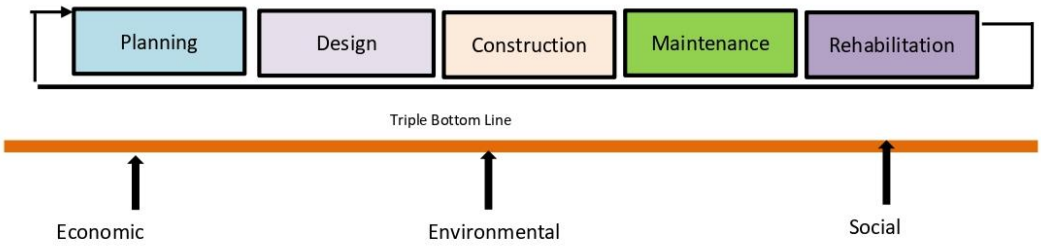

Figure 1.4: A Typical Highway Project (HP) Life Cycle

1.3.2 Components of project management

The following are the major elements of project management:

1.3.2.1 Project planning (PP)

- The plan for project management is a tool that the project sponsor can use to keep the project on track and to focus on the project's primary goal—the timely and successful completion of construction—right up to the final inspection. There is no need to include post-construction closeout activities in the project management plan. The primary objective of the project management plan is to furnish project decision-makers with prompt and accurate information pertaining to various aspects of the project. This is achieved by explicitly delineating the functions and duties of the agency's management and leadership team and recording the established regulations and protocols. Integration management is a kind of project coordination. In this process, we factor in our prior and current knowledge, facts, assumptions, views, and analysis of constraints and opportunities. Plans that work well are the product of using many approaches on this data.
- Project planning begins with project scope management. Scope management also includes procedures for handling modifications to the project's blueprint and list of deliverables. The scope and intricacy of the task at hand may be better grasped when more specific details become accessible.
- In order to identify the activities to be performed, their features, and the methods by which they will be performed, project time management must first gather information on the breadth and depth of the projects and tasks that

will be carried out. Time planning in this context also entails making use of scheduling strategies.

1.4 Research Objectives

1. The objective of this study is to identify the principal factors contributing to delays in the construction of roads and highways within the Iraqi Republic.
2. The degree of severity and relative importance of project delays in the Republic of Iraq's Roads and Highways sector must be assessed.
3. Third, we'll analyze the effect of these identified significant variables on project delays in the highway and roads sector in the Republic of Iraq so that we may design a framework to deal with them

1.5 Research Approach

The researcher has provided a crystal-clear statement of the research issue being investigated in this study. We have addressed the current foundational theory that is relevant to the research challenge. By doing a thorough investigation, the researcher hopes to better comprehend the issue and all its ramifications. In study design, questions are formulated to help with the logical decomposition of the issue at hand. The data mining process starts with the researcher administering a survey using a predetermined set of steps. Analysis of the research data is performed using statistical methods, yielding the study's preliminary results. The variables were combined using the questionnaire to get the factors. The study's conclusions are the detailed factors. In light of this, an empirical study design and method of data analysis are used to create a conceptual lens. Through qualitative study, the conceptual lens contributes to the construction of the whole framework. The overarching research strategy for each of the three aims has been presented.

1.6 Research Design

According to (Kinnear & Taylor, 1987), a research design is "essentially a master plan involving data collection and analyses for a research project." It provides the structure that identifies the information kind, the information sources, and the

information gathering method. When describing research design, it is said that “It is the pattern that is actually adhered to in order to complete the study satisfactorily.

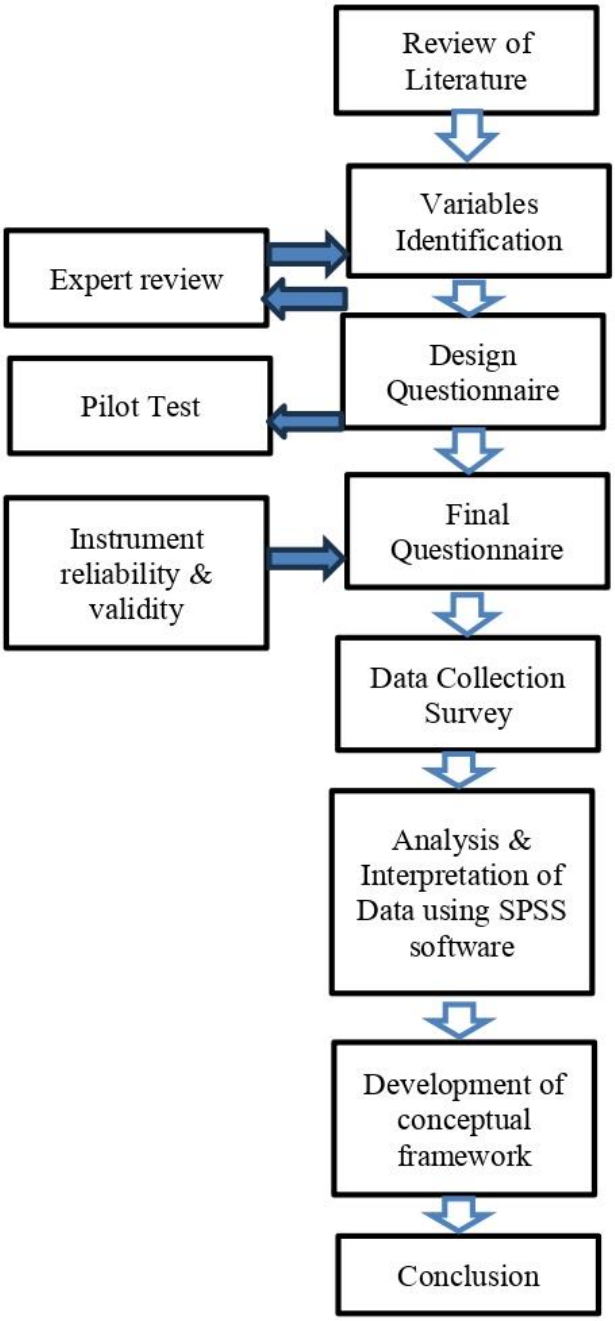

Figure 1.5: Research Design Process

The two most common types of research designs are exploratory and explanatory. It is possible to further categorize the definitive research as either descriptive or informal. According to (Bramble & Callahan, 1987).

Care has been made to include these ideas into the design of the present investigation. The primary goal of quantitative research is numerical quantification, and statistical methods are often used. Both quantitative and qualitative research methods may be used to conduct exploratory and confirmatory studies. Knowledge and comprehension of the issue are gained via qualitative research. Quantitative research must be followed by relevant qualitative research when tackling a novel research challenge (Gahtani & Mohan, 2005). In these studies, a wide variety of research methodologies have been employed.

In order to effectively investigate the research inquiries, a suitable research framework is formulated. Expert reviews, a literature search, and secondary sources are used to determine all variables. Based on these factors, a questionnaire may be designed. After the questionnaire has been designed, a pilot test is conducted to ensure its validity and reliability (Alpha Test-AT). If this is a success, data collecting in the form of surveys may begin. Data processing is performed with the use of statistical methods. From the studied data, inferences, conclusions, and suggestions are derived.

The questionnaire is developed with help from professional evaluations and surveys of relevant literature. Each question is graded on a 5-point scale. This information may then be analyzed using mathematical and statistical methods. A qualitative research approach was utilized to develop a theoretical framework for mitigating delays in the construction of road and highway projects in the Republic of Iraq. The framework was informed by a comprehensive review of relevant literature, factor analysis, and empirical data. The following is a flowchart that explains how research is conducted:

2. LITERATURE ANALYSIS

2.1 Introduction

Due to exposure to natural, human-caused, and environmental conditions, roads degrade and develop a wide spectrum of deformations and faults. These issues threaten economy, public health, and driver and passenger comfort. Periodic maintenance is done daily to remove waste that damages roads, and emergency maintenance is done after accidents. Since delaying maintenance increases repair costs, it should be done regularly. Delaying maintenance raises its cost. Road quality and integrity need a consistent financial commitment. Unfortunately, Iraq's transportation industry has followed the nation's underdevelopment and infrastructural deficit. The absence of a comprehensive regional and local strategy for the sector, insufficient financial resources, substandard institutions, and the intricate and dynamic circumstances resulting from the ongoing conflict have exacerbated an already powerful situation. Basic necessities need infrastructural investment. Thus, productive companies that can reinvest these money are in demand. Beyond investment, a fundamental sectorial shift is needed, followed by a program that supports strategy, vision, institution development, and investment [1-5,28].

This work develops Iraqi road condition models. These models use road quality criteria. These models inform road repair policymakers. It also uses an innovative road management technique to get money for road building and preservation projects. Highway networks (HNs) are costly to develop and maintain, thus planning and study are needed before proceeding. This decision-making method is ambiguous since political, social, and environmental aspects change. A multi-stage stochastic model guides highway construction, operation, development, maintenance, and rehabilitation [3,4].In recent years, national highway networks have evolved in size, complexity, distance traveled, and technological performance. Due to research, building new roads and expanding their carrying capacity is now easier. The road

and highway system developed through time, using particular operating and construction features. Such traits influenced the choice. Repairing and maintaining the system involves a methodical evaluation of construction, operating, and control achievements. As new information and communication technologies evolve rapidly, the possibility of building a full highway management system that helps manage all aspects of highway infrastructure is becoming increasingly possible. Highway authorities have spent the last 20 years evaluating potential road and highway management research and application initiatives [6].Iraq's infrastructure (II), including transportation, has long suffered from its low growth rate and poor condition. This problem has been challenging to resolve because to the absence of a sectorial regional and local plan, persistent underfunding, deficient institutions, and an atmosphere heavily caused by the ongoing war. These factors have made the issue harder to solve. Even fundamental criteria need infrastructural investment. Effective firms that can invest these cash have become more important. Beyond investments, the sector needs a fundamental transformation, which must be accompanied by a program that supports strategy and vision development, institution building, and investment implementation [7,8]. This must be met before financial obligations. Iraq's roadways have deteriorated drastically in recent years. Traditional maintenance, repair, and rehabilitation expenditure is low. Since there are various possible solutions for managing such vital public resources, a system that considers society's needs and ambitions is needed. Highways, and hence Iraq's road transportation infrastructure, face major issues. Examples of barriers include those related to vehicle overload, traffic flow, maintenance procedures, design, materials quality control, and site development. Additionally, there hasn't been enough strategic, efficient national management or pertinent data for decision-makers. A better road management system requires more scientific research on road management, data availability, and methodological statistics [6,11,17]. This is a key obstacle to effective roadway management.

2.1.1 Contemporary roadways

When constructing a new road or highway, engineers and contractors often adopt methods that differ from those previously used. Bitumen and concrete are both useful materials in the construction and improvement of roads and highways. Many freshly

developed tools and pieces of equipment may speed up the construction process while also being cost-effective [80,81]. Roads are built using a range of locally available materials that have undergone extensive laboratory testing, resulting in pavements that are both more durable and less expensive. Over the last several decades, transportation planning has expanded greatly to suit the world's ever-increasing population. As people readjust to modern lifestyles, there will be a greater need for rapid international travel to a wide range of destinations. Several modes of transportation, such as flying and ground and underground transportation like trains and subways, emerged to meet this need. Public transportation was improving, but the private transportation sector was improving far more rapidly. Private transportation's many benefits—including its convenience, suitability, adaptability, seclusion, and opulence—were largely responsible for this. Especially in the realm of personal conveyance, this is the main cause of the recent surge in traffic. Congestion arose as a result, since the expansion of roadway capacity lagged behind the increase in vehicle travel. Additionally, this resulted in a rise in accidents [26].This has led to a resurgence in interest in vehicle management, with the ultimate goal of improving the efficiency of currently available transportation infrastructure. A variety of control devices, including traffic signals, roundabout construction, and speed limits in residential areas, were put into place. Investment in road construction and management increased significantly after both world wars, coinciding with the expansion of roadways and the implementation of more refined regulatory mechanisms. Large projects that need substantial expenditures require people to be aware of the travel pattern and behavior to make the most use of their resources. Therefore, there seems to have an uptick in the research and development of transportation management and planning systems, as well as demand management measures [27]. Since the turn of the twentieth century, vehicle ownership rates have risen as more people take advantage of the enhanced mobility afforded by cars and trucks. Because of this attention and the growing tendency of people moving to urban and suburban fringes, the need for highways and roads has increased significantly. The rising demand for transportation and the congestion of highways are both results of this migration pattern. In contrast, low-density development has proliferated in areas poorly serviced by public transportation. Because of this, accessibility has suffered. When proposed as a solution, the administration of new

roads often received greater support than urban consolidation. Long-term fixes include for keeping the expense of highway transportation reasonable, monitoring land usage, and preserving transportation options other than cars and trucks. Highway transportation planners should think about more than just capacity when making decisions about how to best serve the public. They should consider things like the number of vehicles, their types, speeds, and loads, as well as the public's safety, comfort, and convenience. The ideal world would have major highway management systems set up in a continuous and regular routine. Several stages make up these processes:

- Taking into account the requirements of the route and the available transportation choices.
- Making a system that works for each individually, taking into account their needs and goals.
- Establishing a course that satisfies several criteria, such as those of the economy, the public, and the environment.
- Attaining both the required permissions and funding "Construction, operation, and maintenance of the highway system, as well as the introduction of new concepts for potential future reconstruction."

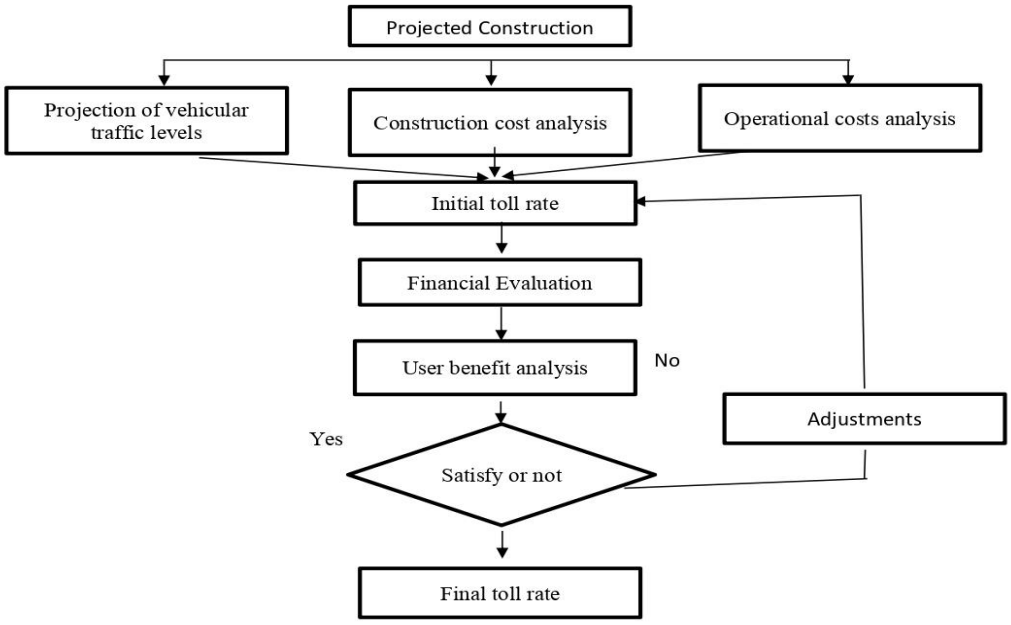

Figure 2.1: Methodology for Setting Toll Rates

2.1.2 Iraq's highways

In the 1970s, the people of Iraq received part of a well-classified road transport infrastructure as a result of continuous economic growth [7-10]. From 1980 to 1988, the war against Iran was reinforced by the continued construction of roads, highways, and trains in eastern Iraq. However, the damage caused during the Persian Gulf War in 1991 was only partially restored, and the disloyal sabotage that began in 2003 caused another wave of destruction.

The road network was mostly damaged by American builders and foreign assistance agencies [28]. According to Sanford (2003), the most important factor in deciding the timing of such repairs was the existing security situation. Around 39,000 kilometers of paved roads and motorways were present in Iraq in 2005. The majority of these roadways were broad interstates constructed in the 1970s and 1980s to accommodate both military and commercial traffic. After the 1991 Road Network and Infrastructure War, most potholes and other problems on roads and bridges were repaired. But since 2003, important Iraqi roads, such as the route between the Jordanian and Baghdad border, have seen more sophisticated acts of sabotage by various groups. Coalition forces destroyed the bridges in 2003, and they became the target of substantial repair efforts in 2004. The Middle Eastern Road network, specifically in Iraq, is exposed to severe environmental factors including elevated temperatures, high soil salinity, increased humidity, substandard construction materials, close proximity to groundwater, and other related challenges. These factors have a significant impact on the overall condition of the road network and the proportion of heavy-duty trucks compared to other types of vehicles. [13-15]. These conditions are aggravated by the increase in the share of heavy trucks. In order to sustain an acceptable level of service for the road network, it is imperative to address any defects through corrective and preventive maintenance techniques such as repair, patching, and renewal. Neglecting to perform this action could result in the malfunctioning of the routing network. Hence, it is of utmost significance to ascertain the design methodology and requisites of roadways in accordance with the prevalent circumstances of the area and ensure their adherence to traffic volumes and stages of progress. Maintenance work encompasses a comprehensive set of measures carried out by the Road Administration to ensure the efficient performance of the

road network and its resilience against the impacts of traffic load and weather-related factors.This objective is attained through the imposition of constraints on the occurrence of various forms of inaccuracies and the implementation of targeted interventions to rectify them in a timely manner. In today's world, modelling traffic characteristics is an incredibly important part of traffic volume. Both lane changing and lane keeping are important aspects of traffic that have been extensively studied. The frequency with which drivers change lanes affects both road safety and efficiency. The distribution of cars between road lanes is an important factor in many factors, such as road structural engineering, traffic management, and driver and passenger protection. Field data were obtained from several different sections of two- and three-lane municipal roads. The results of various field studies and analyses showed that the driving behavior of Iraqi drivers differed from drivers in other countries in terms of lane usage, and similar findings were seen in the behavior of drivers changing. Compared to drivers in other countries, Iraqi drivers use the least number of lanes and change lanes the most. This information is urgently needed in today's world to study and calibrate more complex methods such as simulated microscopy programs. This information is crucial for simulating the reality of driving behavior on rural roads, because it reflects real-life behavior. Despite the efforts and expenditures made to improve their functionality, Iraq's road and highway networks continue to deteriorate in terms of their implementation and maintenance [17,75]. The most important reasons for such damage are repeated manifestations and intensification of deformities in addition to lack of routine maintenance at regular intervals. The Pavement Quality Index (PCI) technique was used to set several objectives to assess pavement quality during visual inspection. A number of studies were conducted using the Micro PAVER application program to determine PCI values based on GIS data. The findings showed that some roads were in poor condition, while others were only in acceptable condition. The establishment of a database of road defects is essential and It is recommended that the database be updated on an annual basis to document the yearly changes in PCI classification.

2.1.3 Road management in Iraq

The Ministry of Works and Housing (MOCH) oversees several Commissions, including the National Commission on Highways and Bridges (NCHB), and these is tasked with executing initiatives pertaining to the development of highways and roads. In addition to maintenance and repair, these functions typically include tracking, tagging, and labeling. Despite the fact that SCRB has all the necessary road equipment to carry out emergency repairs, most road surface works are often carried out by private contractors. The work is often subcontracted by construction companies operating in other countries. In tasks requiring high professionalism, such as road planning and construction, there is participation of private sector companies.

2.2 Delay in Highway-Road Constructions Projects

The output of projects involving the building of highways is mostly dependent on the performance throughout the term of the project. According to [34], the delivery of seventy percent of the construction projects in the United Kingdom was behind the timeframe that was originally scheduled. This was caused by a number of variables, including those that were external to the project, the complexity of the project, ineffective project management, and unrealistic estimates. Furthermore, according to [35], 97% of the projects in Saudi Arabia had delays in the construction project timetable, particularly for road and bridge building projects. This was notably true for road and bridge construction projects. Furthermore, as per the results of a study conducted in Sri Lanka, road construction initiatives experienced delays of approximately 60% longer than the projected duration during the planning stage [52]. Broadly speaking, delays can be classified into three categories, namely excusable delays, non-excusable delays, and concurrent delays [9,10,31,48]. It would seem that contractors or suppliers are to blame for unforgivable delays in situations when the owner is not at fault. Compensable delays and non-compensable delays are the two subcategories that fall under the umbrella term "excusable delays." The party who possesses the owner or their authorized agents bears the responsibility for any instances of delay that necessitate recompense. In situations where delays are attributable to external factors or events beyond the control of the owner and contractor, and are not subject to compensation, neither party bears responsibility for

said delays. The delay in question is attributed to "acts of God," as it is not solely the fault of any one party [31,32]. Concurrent delays are typical delays in building projects. It takes place when more than one cause that might potentially delay the project is detected at the same time or in overlapping periods of time.

Figure 2.2's Pareto diagram displays the frequency distribution of highway contracts that quoted a specific delay factor. As per the diagram, the most commonly cited cause of delay in contracts is "weather conditions," which is followed by "utility networks," "late land acquisition," and "traffic control."

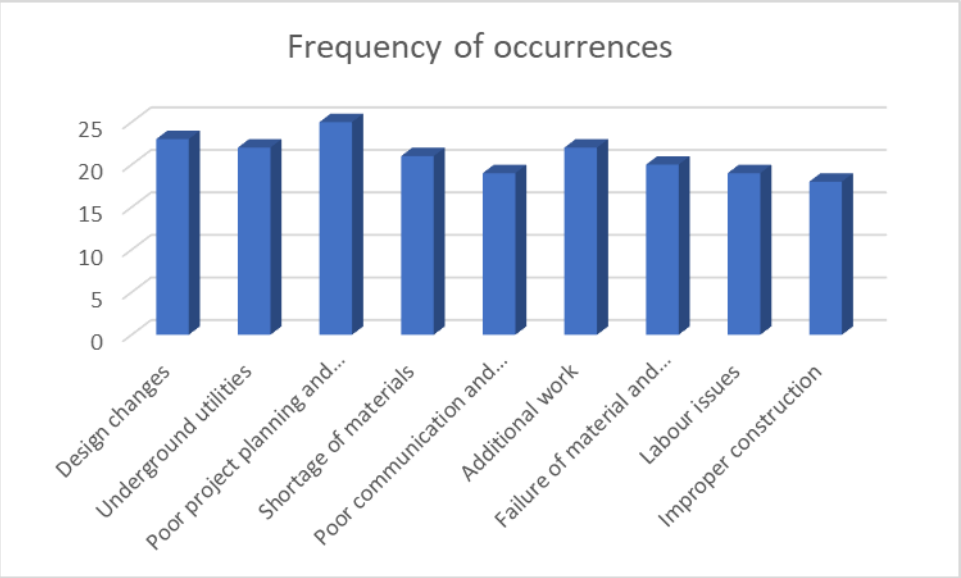

Figure 2.2: Pareto Diagram: Highway Contracts Affected By the Delay Factors

Source: (Shirley and Winston, 2004)

Table 2.1: Significant Factors Causes Delay in Highway Construction Projects

Factors causing delay in highway projects	**Frequency of occurrences**	**Percent-age**	**Reference sources**
Design changes	23	2.21%	[31,33,34,35,37,38,39,40,4142,43,44 45,46]
Underground utilities	22	2.12%	[32,33,35,41,42,43,44,48,49,50,51]
Poor project planning and scheduling	25	2.5%	[31,32,33,35,40,42,45,46,47,52,53,54,55]
Shortage of materials	21	2.02%	[31,33,34,37,42,50,53,55,56]

Table 2.1: (Cont.) Significant Factors Causes Delay in Highway Construction Projects

Factors causing delay in highway projects	**Frequency of occurrences**	**Percent-age**	**Reference sources**
Design changes	23	2.21%	[31,33,34,35,37,38,39,40,4142,43,4445,46]
Underground utilities	22	2.12%	[32,33,35,41,42,43,44,48,49,50,51]
Poor project planning and scheduling	25	2.5%	[31,32,33,35,40,42,45,46,47,52,53,54,55]
Shortage of materials	21	2.02%	[31,33,34,37,42,50,53,55,56]
Poor communication and interaction	19	1.83%	[30,41,47,48,52,53,54,57,59,60,61]
Additional work	22	2.12%	[33,35,39,41,42,50,54,56]
Failure of material and Equipment	20	1.92%	[33,35,39,41,49,58,59,62,63,66]
Labour issues	19	1.83%	[32,34,38,39,40,42,50,56,62]
Improper construction Method	18	1.73%	[32,34,35,38,39,55,61,63,64,65]
Weather	19	1.83%	[32,33,35,36,41,42,43,50,51,62,67]
Poor site investigation	16	1.54%	[32,33,35,36,41,42,58,62,65]
Inexperienced contractors	17	1.64%	[37,39,40,41,42,49,50,55]

The top twelve important factors that contributed to the study are outlined in table 2.1, which can be found above. In addition, the calculation of the percentage based on the frequency analysis has been carried out for each of the key factors, and the results may be found in the table located above. Therefore, on the basis of a comprehensive literature analysis that was carried out, it was discovered that the top most significant causes with a higher frequency of delay occurrences were in the highway construction projects. Table 2.1 illustrates that the main factors contributing to noteworthy delays are categorized as follows: insufficient project planning and scheduling, frequent alterations to the design, numerous underground utilities, unanticipated additional work, insufficient materials, equipment and material

malfunction, inadequate communication and interaction, labor issues, unfavorable weather conditions, unsuitable construction methodology, unqualified contractors, and insufficient site investigation.Insufficient project planning and scheduling (IPPS) has been identified as the primary cause of significant delays. Subsequent to the commencement of construction activities, a multitude of challenges may arise, including but not limited to deficient construction techniques, unskilled labor, insufficient site evaluation, modifications to the original design, the existence of numerous subterranean utilities, supplementary work requirements, material scarcities, equipment, and material malfunction, insufficient communication and collaboration, labor disputes, inclement weather conditions, and incorrect building methodology. According to [40], poor planning was a major factor that contributed to construction delays. No of the scale or scope of a building project, careful planning is essential [60]. Therefore, it is highlighted in [60] that the project will surely fail in terms of the length of time it takes to complete and the amount of money it costs if the planning progresses in the wrong path. According to [47], poor planning is the primary cause of the lengthy delays that characterize road construction in Palestine. Inadequate planning and scheduling are major delay risks in highway and road building projects, as was noted in [50], which is a regular occurrence in Peninsular Malaysia's construction projects. Delays of this kind were commonplace in Peninsular Malaysian building projects. Furthermore [14,37,46] showed that the risk of making alterations to the design is a substantial one that would affect the overall project timeline.

Making changes to the design in the midst of construction causes a variety of complications that extend the time it takes to finish the project. In addition, research by [44] indicated that design changes are the leading source of delays in highway construction projects in Taiwan. If the customer and the consultant don't know about specific local laws, for instance, they may need to make adjustments to the approved design throughout the course of construction or just before work begins. The overall duration of the project would be extended due to this factor. The presence of underground utility wires is a common challenge that must be addressed in order to finish a construction project on schedule [42]. [36] discovered that the presence of subterranean utilities was a major factor influencing the time of the project after examining the situation in Kenya. It takes extra time and effort to complete a

highway building project because of the hidden sources that need to be moved along the route. This meant that it occurred often in the many construction projects taking place in Kenya. Having occurred nine times with an average time extension of 48% on the affected highway projects in Saudi Arabia, the problem with underground utilities was regarded as the fourth most severe, according to [6].

It was also pointed out in [51] that unanticipated changes to the scope of a project are a major cause of highway construction delays in the USA. This was mentioned as a major reason for highway building delays. Recent studies have shown that rework is a major reason why so many Egyptian construction projects go behind schedule [58]. In terms of time, money, and quality, rework was very inconvenient for construction projects overall [62]. More work necessitates more time, which significantly slows down the development of construction projects. On the other hand, several studies have shown that difficulties with the building materials created a major effect on the time required to complete construction projects [49,58,59]. The construction project will have to be placed on hold until the delivery of essential building supplies such sand, cement, stones, bricks, iron, and asphalt, which will cause a major delay in the work progress. As a result, we will be severely behind schedule. An investigation into the causes of schedule and cost overruns in highway building projects in Nepal found that material supply delays were to blame. Because of how temperature-sensitive asphalt is, no building materials may be stored in advance of the start of construction. Asphalt, which is used in construction of roads, is one of these materials. This is a challenging part that adds to overall delays in the road construction process [33,38].

In addition, the construction industry might be hit hard by machinery and equipment failures [42]. For instance, if machinery and equipment are not properly managed, the machinery might break down, delaying the project's execution. The construction of roads necessitated the employment of several pieces of heavy equipment. If the project's machinery and equipment break down, development on the project will have to be temporarily suspended until the replacement equipment arrives on the scene. This is a major factor that causes most road building projects in Iraq to go behind schedule [33]. Inadequate communication and engagement among key players reportedly caused building projects in Saudi Arabia and Afghanistan to be

delayed [47,49]. This component's ranking as the fifth most crucial demonstrates its significance. There's always the chance, for instance, that some construction workers on the site don't speak the native language. This would cause problems for the other people working on the project, and it would make it much more difficult to finish on time.In addition, [39] the spotlight on labor issues, which leads to many undesirable effects like the delay of construction projects in Norway. Unskilled workers, worker absenteeism, worker strikes, and worker disputes all constitute serious threats and difficulties in the Malaysian construction industry, as stated in [31,40]. Research in Egypt indicates that a lack of skilled workers is a major constraint on construction projects there, adding both time and money to their completion [42]. Insufficient qualifications and the utilization of untrained laborers are two of the primary three factors that lead to the postponement of a construction undertaking, each of them having a relative importance score of 0.831, as evidenced by research carried out by [49]. For instance, workers on a road construction site would require specialized training and experience since road building is qualitatively different from other types of construction. Indirectly, this translates to poorer output, especially in road and highway building projects, since workers rotate shifts on a regular basis.

Inclement weather is a prevalent factor that contributes to delays in the construction sector, particularly in the road and highway development domains [36, 51, 66, 67, 72]. As a consequence of the constant rain, even the half-completed work at the road shoulder was carried away at a Canadian construction site [51]. According to a study conducted by researchers [68], the weather conditions in Surabaya city pose a significant challenge to construction projects, particularly those involving roads and highways, due to their exposure to the natural environment. The impact of weather conditions on the duration of construction projects in Pakistan is significant. This is particularly the case when rain caused a failure in the machinery. Road and infrastructure construction in Bahrain is complicated by the country's searing summer heat, which may reach temperatures of 49 degrees Celsius or more [66].The approach to creating roads and highways is crucial because of the vast variations between residential and high-rise development [58]. For example, if anything goes wrong during the milling or paving phases of a road construction project, it will have to be redone from scratch, which is an expensive and time-consuming proposition. Because of this, building a road is unlike any other construction endeavor.

There's little doubt that this will lengthen the overall duration of the project [76]. According to [65], inefficiencies in Sri Lankan construction methods were a major roadblock to the timely completion of a building project. Experience is crucial in the construction industry since it provides a plethora of knowledge that cannot be gained via any other means. The lack of experience among contractors is among the various factors that could potentially prolong the duration of a construction project. The escalation of both price and quality will ensue as a consequence of this phenomenon. In accordance to research conducted by [37], the fourth most significant factor contributing to delays in construction projects is attributed to contractors who lack competence and skills. Yes, unskilled contractors will have trouble comprehending the complexity of a construction project, leading to misunderstanding and confusion, and maybe falling behind in the job [39,76,79]. The results of controlled experiments show that increased danger is present in the construction business when competent contractors are few. In addition, earlier studies in Jordan indicated that incompetent contractors are a major cause of construction schedule overruns. This turned out to be true. To provide one concrete example, the project schedule might be negatively impacted by a lack of suitable approach in building. The danger of using unskilled labor is linked to the presence of an inexperienced contractor, as indicated in [69]. Due to problems obtaining visas, work permits, and licenses, many novice contractors may be unable to employ qualified personnel, which has a knock-on effect on the building project and delays its completion. The outcomes suggest the comprehensive effectiveness of the expressway infrastructure development initiative, demonstrating the significance of expertise. This demonstrates the significance of possessing experience. In addition, doing a site study is a crucial first step in the building process that must be taken seriously if the project is to be completed successfully, economically, and on schedule [56]. However, the bulk of studies used inadequate site research methodologies, which acted as a barrier to numerous construction projects, most notably road and highway construction projects.

The substandard quality of site studies conducted has been identified as a primary factor contributing to the unsuccessful completion of numerous highway construction endeavors in Iraq, as per sources [33,66]. Despite the obvious importance of such investigations, this is often overlooked. In addition, the high prices of many highway development projects in Slovenia might be attributed in part to the sluggish speed of

construction activity [58]. This is largely the consequence of a poor site survey performed early in the project, which in turn slowed down building [58]. Therefore, it highlighted the need of conducting thorough site investigations.

3. RESEARCH DESIGN AND METHODOLOGY

3.1 Overview

In this section, the researcher will detail the study's in-depth approach and methodology. Extensive discussion is given to the study's methodology, including its research strategy, methods, and the instruments and methods it used. The introductory section of the chapter delves into a comprehensive analysis of the mechanics of research and its potential methodologies. Subsequently, a discourse on the research technique as well as study methods employed particularly in the domain of information systems ensues. Significant effort has been dedicated to clarifying and distinguishing the differences in technique and research technique.

3.2 Introduction

To put it another way, the research design can be thought of as the investigation's plan or blueprint. To be more specific, numerous scientific concepts, methods, statistical methods, study designs, and data analysis strategies were incorporated into the overall framework of the research. The research design essentially outlines the chain of reasoning that starts with the study's hypotheses, moves through the collection and analysis of empirical data, and arrives at the study's findings. (Yin, 2003).

Exploratory research designs and definitive research designs characterize the research process. Research that ends in a conclusion may be split into two subcategories: descriptive and causal. Quantitative studies are more often linked with decisive research, whereas qualitative studies characterize exploratory research. In this thesis, both types of studies served distinct purposes.The qualitative approach was utilized throughout all stages of the study, including the literature evaluation, the formulation of the study's goals, the validation, and the establishment of the primary purpose of the investigation. The general process and justification for using a

qualitative approach have been outlined. The study's strategy for gathering qualitative data has been outlined. Internal and external validity, as well as construct validity, have been examined in relation to the qualitative research approach (Yin, 2003). The interview's conceptual lens and methodology have been presented and discussed. Quantitative methods were used to determine the method of sampling (sample size, sampling frame), create scales, pilot test the instrument, ensure its validity and reliability, create the questionnaire, gather the data, and analyze the results.

3.3 Background

Delays in highway and road construction projects are bad for businesses on both sides (road agencies lose money and contractors incur additional expenses) and may also lead to disagreement and expensive litigation over who is legally responsible for the delay. Highway developments in the Republic of Iraq are being significantly impeded by cost overruns and delays, raising the capital production ratio for the economy as a whole and stifling development potential, diminishing competitiveness, and decreasing resource efficiency. There are issues with prolonged construction zones, concurrent safety and roadwork delays, anger among road users, and political repercussions. The time, money, security, and quality of a project all suffer as a consequence of delays. bad emotions, mistrust, litigation, arbitration, cash flow issues, and overall unease are just some of the bad outcomes that might result from a project's delays.

There are a number of causes for road project holdups, some of which are the duty of the contractor and some of which are the responsibility of the customer. Conflicting occurrences make it difficult to isolate the specific causes of the substantial delay and identify the guilty parties. Conflict, negotiation, litigation, arbitration, and even project cancellation may result from delays.

Delays in a project cause:

Traffic-delays Political Consequences

Poor communication between those involved Distrust amongst those involved. Discontentment amongst road users Conflict resolution Lack of available funds.

Repercussions that are harmful to the project's bottom line, quality, and safety Delays have varying impacts depending on who is affected. The results are a waste of resources (money, time, and energy). When a project is delayed, the contractor loses money because it must spend more money on resources (such materials and tools) and human resources (like new hires). Delays cause financial losses and facility inaccessibility for the client. Parties to a contract may settle disputes over R&H project delays by submitting claims for additional dollars and/or time.

3.4 Research Design

The plan of a project specifies the kind and subtype of research questions to be addressed, as well as the guiding theory, essential ideas, dependent and independent variables, the experimental setup, and, if necessary, techniques for gathering data and a static analytical strategy. To answer the research problems at hand, a research strategy was created. Ultimately, a research plan was developed. The research plan is like a blueprint, outlining the steps to take in order to collect and analyze reliable data from a variety of sources. The goal is to specify the scope of the study or relevant areas of inquiry. The purpose of this structure optimization effort is to distinguish between the expenses of attaining different levels of precision and the expected reward in terms of information about all degrees of accuracy.

3.5 Types of Research

Based on the objective, technique, and scope of the study, research can be roughly categorized into numerous types. Here are some examples of common forms of research:

Basic Research: Expanding understanding and knowledge in a given topic is the goal of basic research, sometimes referred to as pure, fundamental, or academic research. It is driven by intellectual curiosity and does not necessarily have immediate practical applications. Basic research often lays the groundwork for further applied research.

Applied Research: Applied research aims to solve specific practical problems or address practical challenges. It takes existing knowledge from basic research and

applies it to real-world situations. The goal is to develop or improve products, processes, or services. Applied research is often conducted in collaboration with industries or organizations.

Quantitative Research: In quantitative studies, statistics are gathered and analyzed to better understand and explain events. It focuses on objective measurements, statistical analysis, and numerical representations. It often uses techniques such as surveys, experiments, and statistical modeling to draw conclusions.

Qualitative Research: Qualitative research focuses on understanding and interpreting subjective experiences, meanings, and social contexts. It involves collecting non-numerical data through methods such as interviews, observations, and focus groups. Qualitative research aims to explore in-depth perspectives, attitudes, and behaviors of individuals or groups.

Experimental Research: Experimental research involves the manipulation of variables in a controlled environment to establish cause-and-effect relationships. Researchers design experiments to test hypotheses and examine the impact of specific factors or interventions. It often involves the use of control groups, randomization, and statistical analysis.

Observational Research: The observational study includes observing and documenting actions, occurrences, or phenomena without making any direct changes to the situation or modifying the variables. It aims to describe and understand natural processes and behaviors in their real-world settings. Observational research methods include participant observation, field studies, and archival research.

Case Study Research: research is concerned with in-depth analysis of a specific individual, group, organization, or situation. It often involves collecting qualitative and quantitative data from multiple sources to gain a comprehensive understanding of the case. Case studies provide detailed insights into complex phenomena and can be used to generate hypotheses or theories.

Exploratory Research: Exploratory research aims to explore new or unfamiliar areas to gain a preliminary understanding and generate research questions or hypotheses. It often involves literature reviews, pilot studies, or initial data collection

to inform further research. Exploratory research is flexible and helps researchers identify research gaps or emerging trends.

Descriptive Research: Descriptive research aims to describe and document characteristics, behaviors, or phenomena in a systematic and objective manner. It entails gathering information through questionnaires, observations, or records already in existence, then summarizing the results using quantitative or qualitative terms.

Comparative Research: Comparative research involves comparing and contrasting different groups, populations, or variables to identify similarities, differences, or patterns. It aims to examine the impact of various factors or interventions across different contexts or settings. These are some of the common types of research. Researchers often employ a combination of these approaches based on their research questions, objectives, and available resources. The nature of the study topic and the anticipated results influence the choice of research type.

3.5.1 Exploratory analysis

To better define objectives, provide actionable thoughts, and strengthen the final study design, data collecting techniques, and topic range, exploratory research has been conducted on an unresolved problem. And it should proceed with extreme care before making any firm judgments.

3.5.2 Descriptive analysis

Descriptive analysis is used to categorize the studied population or phenomenon. It doesn't explain when or why the characteristics emerged. The query "what?" is posed. Descriptive categories, a kind of categorization strategy, are often discussed. Descriptive analysis is unable to zero down on the causal chain that links one factor to another. Descriptive analysis, on the other hand, is acceptable despite meeting just a minimal standard of internal validity. Comparing methods is at the heart of every good study design.

- Set forth your research's objectives.
- Data for addressing study problems will be set aside as required.
- Exploratory learning that is both casual and instructive.

- The time and method of sampling must be specified.
- Create a strategy for analyzing and tabulating data.
- Assessing the morality of scientific research.
- budgetary constraints, time constraints, and detailed requirements
- Finish an investigation or study.

The primary focus will be on research data, and the findings will be presented in an innovative way. More than that, it backs up the conclusion drawn in the abstract and adds to the study's well-executed methodology. This research is diagnostic in nature as well as exploratory, using both primary and secondary data. A number of factors, and district presence, deposit mobilization, and lending and investment strategies, will be scrutinized. According to the report's intended use, the information will be tabulated and categorized. Here are some good places to look for both primary and secondary sources of information:

Primary Data

The term "primary data" pertains to data that is collected by researchers directly from original sources, including but not limited to interviews, surveys, experiments, and other techniques. In research, primary data is commonly obtained directly from its source and is regarded as the most valuable type of data.

The selection and customization of primary sources of information are commonly undertaken to meet the specific needs or prerequisites of a particular research project. Prior to selecting a data collection source, it is imperative to identify factors such as the research objective and the intended population.

The present investigation predominantly relies on primary data, which was gathered through the utilization of the following research instruments:

Questionnaire

Questions and suggestions for more data collection are what make up a questionnaire. The questionnaire serves as a testing instrument, and its data collection relies on following a predetermined inquiry structure and timetable.

- **Interview**

The utilization of interviews as a research methodology involves the collection of qualitative data through the conduct of comprehensive one-on-one interviews with a restricted number of participants. The purpose of this approach is to explore the perspectives of the participants regarding a particular concept, program, or situation. Supplementary data and further information were obtained through comprehensive interviews conducted with senior executives of Highway projects, members of the ministry of work and housing committee, and other authorities of the state government. In addition to utilizing surveys, we also conducted interviews with both borrowers and contract authorities to validate and ensure the accuracy of the data.

- **Statically tools used**

The information gathered from primary as well as secondary sources was organized and evaluated using econometric and statistical methodologies. In this study three and five-point Likert scale have been used. Arithmetic mean, percentage, standard deviation, skewness, correlation co-efficient, t-test, chi-square test, other econometric tool such as linear trend and exponential compound growth rate have been calculated in order to draw proper inferences and results. The formulas used for the above purposes are explained in the successive paragraphs.

3.6 Research Problem Statement

How to create a framework for project delay reduction by controlling project limitations through impact evaluation of critical causes causing schedule overruns in Iraqi road and highway construction.

3.7 Research Questions

What are the primary reasons for delays in projects in Iraq's road and highway sector?

In the Roads and highway sector in the Republic of Iraq, what extent do the identified major causes driving project delays have?

How do these crucial elements affect project delays, and what can be done to prevent them?

3.8 Nature of Research Question

Getting to the bottom of what causes project delays and what aspects are most important to identify is an exploratory research topic. The factors mentioned above have an impact on project

delays in the Republic of Iraq's roads and highways sector. The research seeks to highlight appropriate suggestions by building a framework to decrease project delays by analyzing and assessing the importance of every aspect.

Mixed Methodology

The total power of a study is greatly increased when qualitative and quantitative elements are combined and used in conjunction using a mixed method technique. Researchers using mixed methods draw on the best of both qualitative and quantitative approaches.

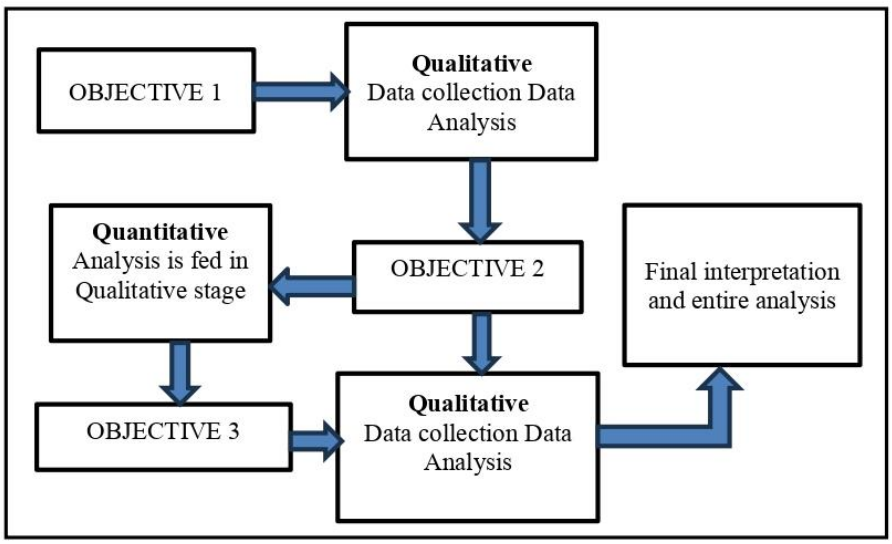

Figure 3.1: Research Methodology

Mixed-method or sequential study design is defined as the gathering and analysis of quantitative data in the initial phase, which is followed by the gathering and analyzing of qualitative data in another phase according to the preliminary findings of the first stage.

The combination of methods offers a more comprehensive grasp of research problems. The main downside of this strategy is that it takes longer to collect data because two different stages are required (Creswell, Clark, & Plano, 2007).

3.9 Research Methodology and Data Analysis

3.9.1 Research variables

Develop a structure to prevent project delays by identifying a list of significant research factors from the literature survey.

3.9.2 Respondent's profile

Experts from the Republic of Iraq's roads and highways industry (Clients, Consultants, and Contractors) are being surveyed.

Using a judgmental sample method, we will choose survey takers from the following demographics:

1. Project managers and technical executives at the PARB, MOWH, CPWD, etc.
2. Higher-ups in the roads and highways sector 2.
3. Project Management Consultants with experience in the roads and highways sector.

Fourthly, highway and road industry contractors and site execution engineers Both electronic and print copies of the questionnaire were sent out upon request, and a total of 123 valid replies were received from clients, contractors, and consultants. Due to respondents' thorough comprehension of the questionnaires, their personal contacts, and their relevant industrial experiences, the data collected was found to be exceptionally reliable for analysis (Vaus, 2001). The majority of those who responded were contractors (38%), followed by customers (33%), and then consultants (29%).

3.10 Calculating sample size

To perform sample size computation, it is recommended to utilize the formula proposed by Yamane et.al (1967), which involves the percentage of consultants being 29%. A comprehensive discussion of the data analysis methodology for each of the objectives has been presented.

Table 3.1: Statistical Data

Statistic	Description	Value
N	Sample size	384
E	Margin of Error (as a decimal)	5%
N	Population Size	10000

$$n = \frac{N}{1+N(e)^2} \quad \textbf{(3.1)}$$

$$n = \frac{10000}{1+10000(0.05)^2} = 384\ respondents$$

Equation 1: Calculating Sample Size

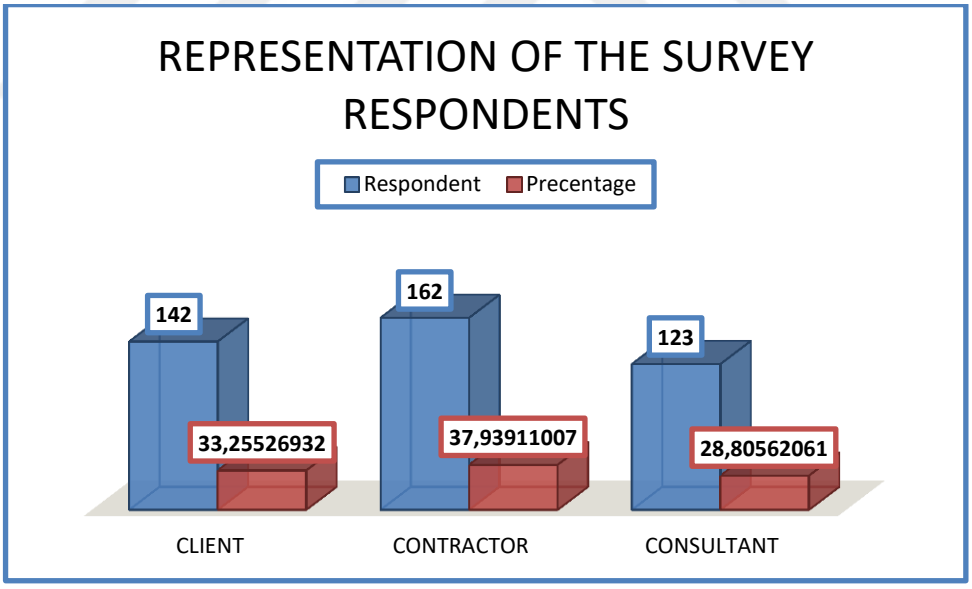

Figure 3.2: Representation of the Respondents

Figure 3.2 depicts the distribution of respondents by client, contractor, and consultant. The participants in the survey comprised 33.25% (142) of the client populace. The contractor reflects 37.93% (162) of the survey respondents, while the consultant reflects 28.80% (123) of the survey respondents. In above figures show different respondent which fill the questionnaire we take all participant

which related to road project management and try to equal percentage which filled questionnaire, in this try the approach and justification for the proposed study are discussed in depth and in a logical manner by describing the research methodologies and the research study.

QUESTIONARE

1. **SEX**

   MALE

   Female

2. **Project complexity (Project type, project scale, etc)**

   Very Low

   Low

   Moderate

   High

   Very High

3. **Improper conflict resolution process adopted**

   Very Low

   Low

   Moderate

   High

   Very High

4. **Improper contractor/Consultant selection**

   Very Low

   Low

   Moderate

   High

   Very High

5. **Lack of client representatives at site**

   Very Low

   Low

   Moderate

   High

Very High

6. **Transfer/ Changes in project employees occur during the course execution of the project.**

   Very Low

   Low

   Moderate

   High

   Very High

7. **Global/ National Economic crises**

   Very Low

   Low

   Moderate

   High

   Very high

8. **Situation of law and order/security threats/local agitations**

   Very Low

   Low

   Moderate

   High

   Very high

9. **Problems with client-purchased materials**

   Very Low

   Low

   Moderate

   High

   Very High

3.11 Highway Project Economic

When it pertains to managing highway projects, the economy is one of the most important things to think about. Here are some key economic factors that should be taken into account:

Budget: In terms of money, the budget constitutes one of the most important parts of managing the construction of a highway. It is important to know how much money is available for the job and to make sure that all costs are kept within this budget.

Cost estimation: Accurate cost estimation is essential in highway project management. It helps to ensure that the project remains within budget and that the funds are allocated appropriately.

Financing: Highway projects can be very expensive, and financing options need to be carefully considered. Financing options can include government funding, private investment, and public-private partnerships.

Economic impact: Highway projects can have a significant impact on the local economy. It is essential to think about the financial advantages the development will provide to the area, such as more trade and tourists, and to make sure that those advantages are achieved.

Environmental impact: The environmental impact of highway projects can also have economic consequences. For example, environmental damage can lead to costly clean-up efforts, while environmental protection measures can increase project costs.

Efficiency: Management of projects that works well can help keep costs down and make sure the project is finished on time. This can include measures such as effective communication, streamlined decision-making, and careful resource management.

In general, when managing highway projects, it's important to think carefully about economic issues. By putting these things into consideration, managers of projects can make sure the project stays on budget, helps the local economy, and has the least amount of effect on the surroundings possible.

3.11.1 Highway project economic example

Let's say a city is planning to build a new highway to connect two major cities in the region. The project is expected to cost $500 million, and the city has secured funding from both the federal government and private investors.

In order to handle the project's finances, the project manager needs to make decisions about a few key things:

Budget: The project manager would need to ensure that the project remains within the $500 million budget. This would require careful cost estimation and management of all project expenses.

3.11.2 Highway Project in the lraq

Highway projects in Iraq require upkeep, rehabilitation, and the implementation of fresh initiatives due to the significant impact of wars and financial circumstances. Therefore, the General Authority for Roads and Bridges, in cooperation with road companies, has established many highways with funding from the World Bank.

This many examples about highway projects in lraq:

I. **The Roads Department is completing the right lane project for Samawah-Nasiriyah Road, 6th floor, within Highway No. 1**

The Roads and Bridges Department of the Ministry of Construction, Housing and Public Municipalities on April 2023 has completed the work of the right lane project for Samawah-Nasiriyah Road, 6th floor, one of the sections of Highway No. Al-Muthanna and Thi-Qar are 48 km long and 15.5 m wide. The work of the road section extending from km (0.00 + 47 – 0.00 + 95) was completed by the Ashur General Company affiliated with the Ministry at a total cost of about 105 billion Iraqi dinars with spare orders, and it was opened to the movement of vehicles.

The work included covering the road with the surface layer using Improved polymeric materials for bitumen that increase the efficiency of asphalt to be more suitable for withstanding high temperatures and large loads.

The works also included the implementation of a polymerized bitumen pavement, furnishing works, erection of traffic signs (warning and indicative), planning and erection of wire and protective fencing and new Jersey barriers.

Figure 3.3: Highway No.1 Samawah- Nasiriyah Road

II. Highway of the construction project for the second lane of road in Wasit Governorate.

The Roads and Bridges Department of the Ministry of Construction, Housing and Public Municipalities has achieved advanced work stages of the project for the construction of the second corridor of (Kut-Badra-Mahran-KBM) road / the first phase in Wasit Governorate, which is included in the government program projects, with a completion rate of about 92% on April, 2023 of the construction project for the second lane .The road is 40 km long and 8 m wide, and it will contribute to reducing traffic momentum, raising safety and security levels, facilitating the movement of travelers and visitors, and trade exchange with neighboring Iran, as it connects the governorate to the Zurbatiya border crossing.

The project is being implemented through the Hamorabi General Company affiliated with the Ministry, at a total cost of about 42 billion Iraqi dinars with spare orders, as more than 24 km of the road has been completed and received in advance, while the remaining works continue from the last section of the extended road within the Hor Al-Shuija area.

Figure 3.4: Highway No. 2 (Kut-Badra-Mahran)

3.11.3 Highway project in Kurdistan lraq

In 2010, the KRG drafted a 20-year master plan to widen and split all important roadways. Nearly a thousand kilometers of roads in the Kurdistan Region were supposed to be split by 2022 according the master plan. A series of economic problems delayed the initiative. Drivers in the Region face significant challenges due to poor road conditions. In 2019, auto accidents accounted for the second-highest mortality toll in the Region.

According to statistics compiled by the KRG Ministry of the Interior, 36,913 auto accidents occurred between 2010 and 2018, resulting in 6,509 fatalities and 77,362 injuries.It's true that this road improves accessibility, but we still want to travel on it as safely as we can. All vehicles and pedestrians must obey the police orders.

a. The strategic 150-meter road project in Erbil:

The duration of work on the project is about 800 days, and work began on September 17, 2018The 150-meter highway (Al-Hawli) surrounds the city of Erbil and is 70 km long. It is a double road (round trip) with a width of 20 meters in each direction. There are also two service streets, each 24 meters wide, parallel to the road path on its right and left.

It has all the necessary components, including an irrigation and drainage system, a lighting network, traffic signs, road lines, protective fences, and pedestrian bridges for citizens and the (middle carrot).The previously opened distance was 14 km out of 70 km of the total length of the road, but the current work and paving area amounts

to about 65 km of double direction with a width of 15 .The highway project is the sixth road that surrounds Erbil in the form of a circular ring, and work began on it within five stages and at a cost of 131 $ million, under the supervision and design of the engineers of the Kurdistan Region.

The main road contains 5 lanes in each direction, used for emergency cases, while the service road includes 4 lanes, with two lanes in each direction. The road is equipped with 14 bridges, 8 tunnels, and 3 pedestrian paths. The part to be completed extends over a distance of 7.2 km and includes the Erbil-Koysanjak Road and Erbil-Shaqlawa Road, with the construction of service streets from two directions according to the laws and instructions in force. The "Hemin Group" group of companies is implementing the 150-meter project, and has so far completed the part extending from Erbil - with a movement to Erbil - Shaqlawa. It is hoped that the project will contribute to relieving traffic jams in the capital of the Kurdistan Region.

The road was provided with an irrigation and drainage system along a length of 10 km, for about 20,000 housing units located on both sides of the road, in addition to 3 vehicle turns, 3 pedestrian paths, 4 bridges and two tunnels at the intersection of Bharaka and the road of the Erbil Traffic Directorate. Many other components have been established such as a lighting network and fences.

Which was taken into account in 50 km of project design, and there are 1,600 electric poles along the road. The 150-m ring road overlaps with each of the outlets of Erbil-Dohuk, Erbil-Sulaymaniyah, Erbil-Mosul, Erbil-Kirkuk, and the road was designed by Kurdish engineers. The street paving is made of 3 layers, with a total thickness of 20 cm. The outer layer is made of a polymer material of the kraton type, to be resistant to summer heat and winter cold, and to be able to accommodate the weight of a large number of cars and trucks. The road enjoys special importance from a commercial point of view, because it facilitates movement with the governorates of Dohuk and Sulaymaniyah, that is, it connects the borders of the Kurdistan Region with Turkey on the one hand, and the borders of the Kurdistan Region with Iran on the other. Two thousand local workers work on the road, as long as the project is being completed, which is being implemented by local experts.

The rainwater drainage system will extend along 60 km of the road using high-density polyethylene. The all materials used in the project were provided from within

the Kurdistan Region, with the exception of small parts of the bridge components, which were imported from abroad On February 25, 2021 the President of the Kurdistan Regional Government, Masrour Barzani, inaugurated a part of the 150-meter ring road in Erbil, which is the first in terms of design, quality and materials used in the project at the level of Iraq and the Kurdistan Region.

Figure 3.5: Highway No. **3** (**150**-Meter Erbil)

b. The two-way Roviya-Gopal

The project consists of (22 km) a main road and (3 km) a secondary road, the width of each of them is (72 meters) and it consists of two (dominant) sides, each side includes three lines, and it includes a side street with a length of (16 km).) and a width of (9 meters), and the project also includes a street with two (dominant) sides, a length of (16 km), which includes two lines, as their width is (9 meters), with (6 six) high bridges to turn around, and a hydro bridge, and it includes (96) road water costs And a location to cross animals, 95% of the project was completed in 2019. The public road is part of the major route between Dohuk and Erbil, a key and essential commercial corridor. Kavin Group financed and managed the project. A large section of the Erbil-Duhok motorway inaugurated on October 20, 2020.The Kurdistan Regional Government (KRG) is building two other projects as part of its service improvement plans: a 38-kilometer two-way road with two lanes and a budget of 157 million, and a 128-meter bridge between the two roads with a 35$ million budget.

Figure 3.6: Highway No.4 (The Two-Way Roviya-Gopal)

3.11.4 Financing

It is imperative for the project manager to guarantee adequate financing for the project. This could involve negotiating financing terms with private investors and securing additional government funding if necessary.

3.11.5 Economic impact

The project manager would need to consider the economic impact of the new highway. This could include assessing the potential increase in trade and tourism, and considering how the highway will impact existing businesses in the region.

3.11.6 Environmental impact

The assessment of the environmental ramifications of the novel highway would necessitate the project manager's attention. This could include conducting environmental impact assessments, and implementing measures to minimize damage to the local ecosystem.

3.11.7 Efficiency

The project manager's responsibility would be to guarantee the project's timely and effective completion. This could involve streamlining decision-making processes, optimizing resource allocation, and ensuring effective communication between all stakeholders involved in the project.

3.12 Highway Project Risk Management

Risk management (RM) is a significant aspect of any highway project, as there are a variety of risks that can impact the project's success. Here are some key steps in highway project risk management:

3.12.1 Identify risks (IRs)

Start by identifying all potential risks that could impact the project. This includes risks related to project design, construction, operation, and maintenance.

3.12.2 Assess risks (ARs)

Once the risks have been identified, their likelihood and possible effect on the project can be evaluated. This will aid in prioritizing risks and identifying those that need the most focus.

3.12.3 Develop a risk management plan (RMP)

Develop a plan to address each identified risk. This should include strategies for reducing, mitigating, or avoiding the risk altogether.

3.12.4 Monitor risks (RSs)

Regularly monitor the identified risks throughout the project's lifecycle to ensure that the risk management plan is effective.

Adjust the plan as needed: If new risks arise during the project, adjust the risk management plan accordingly to address them.

Some specific risks that may be associated with highway projects include:

3.12.5 Environmental risks (ERs)

Construction and operation of highways can impact the environment, including air and water quality, wildlife habitat, and natural resources. Environmental risks should be identified and addressed through mitigation strategies such as erosion control, pollution prevention, and habitat restoration.

3.12.6 Construction risks (CRs)

Construction projects involve a variety of risks, including delays, cost overruns, explosions and accidents. Risk management strategies may include careful planning, regular inspections, and safety training for workers.

3.12.7 Maintenance risks (MRs)

Highways require ongoing maintenance to remain safe and functional. Risks associated with maintenance include inadequate funding, outdated infrastructure, and equipment failure. Risk management strategies may include regular inspections and maintenance schedules, as well as emergency response plans in case of equipment failure or other unexpected events.

3.13 Project Planning

Highway projects can be accomplished on time, under budgetary constraints, and with minimal damage to the environment as well as neighboring communities if risks connected with these projects are successfully managed by project managers.

Imagine a state is planning to build a new highway through a forested area. The project team identifies several risks that could impact the project's success, including:

3.13.1 Environmental risks

Construction of the highway could impact wildlife habitat, soil erosion, and water quality.

3.13.2 Construction risks

There could be delays and cost overruns due to unexpected weather events, equipment failure, or accidents.

3.13.3 Maintenance risks

Ongoing maintenance may be difficult due to the remote location of the highway and the need for specialized equipment.

To deal with these risks, the project's team makes a plan which involves the subsequent steps:

3.13.4 Environmental risks

The team conducts an environmental impact assessment and develops a mitigation plan that includes measures such as erosion control, replanting of trees, and water quality monitoring.

3.13.5 Construction risks

The team plans for potential delays by building in extra time for construction and preparing contingency plans in case of unexpected events. They also implement strict safety protocols and provide ongoing training for workers.

3.13.6 Maintenance risks

The team develops a maintenance plan that includes regular inspections, preventive maintenance schedules, and emergency response plans in case of equipment failure.

Throughout the project, the team regularly monitors risks and adjusts the risk management plan as needed. By effectively managing these risks, the project was finished on time, on budget, and with little damage to the environment and towns nearby.

Highway project planning, project strategy, project cost-based management, and project quality control are all important aspects of managing a successful highway project. Here's an overview of each:

3.13.7 Highway project planning (HPP)

This involves the initial planning and organization of the project. It includes identifying project goals and objectives, selecting project team members, defining project scope, developing project timelines and schedules, and identifying project risks and opportunities.

3.13.8 Project strategy (PS)

This involves developing a clear strategy for how the project will be executed. It includes defining project deliverables, identifying project stakeholders, developing a communication plan, and identifying project risks and opportunities.

3.13.9 Project cost management (PCM)

Costs must be monitored and controlled to ensure the project stays within its allotted budget. Creating a budget, monitoring spending, analyzing cost differences, and making necessary adjustments are all part of this process.

3.13.10 Project quality control (PQC)

This involves ensuring that the project meets the quality standards and requirements set out in the project plan. This includes developing quality standards, monitoring project performance, conducting regular quality audits, and implementing corrective actions as needed.

These four facets of project management are intrinsically linked in a highway construction project. Efficient project planning, for instance, is crucial for coming up with a crystal-clear strategy for the project, and efficient cost management is essential for completing the project without going over budget. To guarantee the project succeeds and provides the promised advantages, quality assurance is essential. Project managers can improve the likelihood of a successful outcome for a highway construction project by keeping these four factors under control.

3.13.11 Highway project planning

The project team identifies project goals and objectives, including improving traffic flow and reducing congestion in a specific area. They select project team members and define the project scope, which includes building a new four-lane highway over a 3-mile stretch of land. They also develop a project timeline and identify potential risks such as weather events and environmental concerns.

3.13.12 Project strategy

The project team develops a clear strategy for how the project will be executed. They define project deliverables, which include the construction of the new highway, the installation of new traffic signals, and the establishment of a regular maintenance schedule. They identify project stakeholders, such as local residents and businesses, and develop a communication plan to keep stakeholders informed throughout the project.

They also identify project risks and opportunities, such as the potential for cost savings through the use of new construction techniques.

3.13.13 Project cost management

The project team creates a budget and monitors spending to guarantee that it stays within set parameters. They identify cost variances, such as unexpected increases in material costs, and make adjustments as needed. In order to guarantee that the work is finished on time and within budget, they also keep an eye on its progress.

3.13.14 Project quality control

The project team develops quality standards for the construction of the highway and conducts regular quality audits to ensure that these standards are met. They monitor project performance, such as traffic flow and safety, and implement corrective actions as needed to address any issues that arise.By effectively managing these four aspects of highway project management, the team working on the project may assist to make sure the job is done on time, on budget, and to the quality standards that were set. The result is a new highway that meets the needs of local residents and businesses and improves traffic flow in the area.

3.14 Case Study

The chosen roadway is historically and culturally significant. It's a key thoroughfare that links Baghdad and the southern governorates to the north, as well as the main tourist attractions and religious sites in the south. It also links the southern province of Basra and the western province of Al-Anbar to the nation's capital of Baghdad. The 15-kilometer stretch of multi-lane highway chosen extends from the Baghdad junction of Al- Dora to the two branches at the Al- Rashid interchanges. As may be seen in Figure (3.8), the multi-lane highway links the Iraqi freeway network with the Baghdad city expressway network, including the International Baghdad Airport.

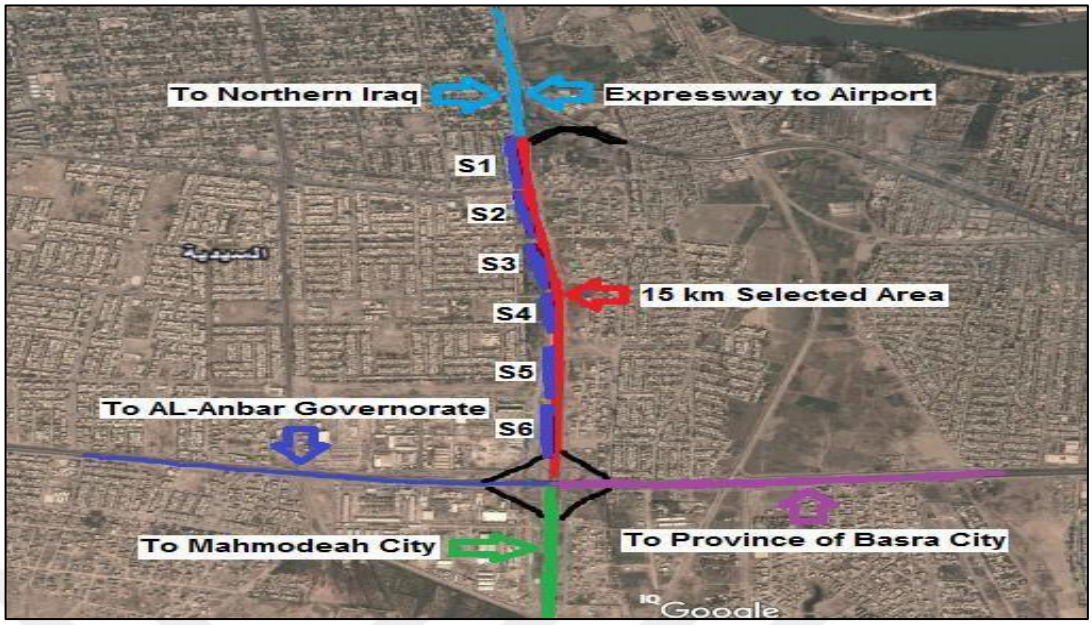

Figure 3.7: Screen Shot of An Aerial Picture from the Al-Dora Intersection to the Al-Rashid Interchanges, Taken with the Google Earth program

Heavy trucks transporting products to and from Baghdad's capital city cause severe congestion on this roadway at various times of the day. Figure (3.7) depicts how the highway was partitioned into six sections, with boundaries established according to factors like traffic density, frequency of use, percentage of high-speed travel, and number of access points.

Data Collection

Highway data was broken down into three categories: route geometry, vehicle speed, and traffic volume. The traffic data used in this research was gathered mostly by visual observation. The installation of surveillance cameras at various points along the route provided the raw data used in the assessment and redesign processes. To determine the annual increase in traffic volume on Iraqi roadways, the Traffic Department at the Ministry of Interior was communicated by state entities in the government, public, and mixed sectors. Data gathered over the years reveals that the number of automobiles is increasing at a pace of 6.2% every year. Multiple trips were made to the research area's field locations in order to determine the highway's geometric and traffic statistics, establish the highway segments, and gather the necessary information for the analysis.

HCM advised using ideal circumstances and default values to fill in the gaps in the data. Each segment's speed restriction was established after careful inspection. From

this upper bound, we calculated the BFFS, or Base Free Flow Speed. The HCM 2010 BFFS represents the posted speed plus 5 mph (8 kph) for multi-lane highways with specified limits of 50 mph (80 kph) or above; for speed restrictions of 50 mph (80 kph) or less, the BFFS equals the posted speed plus 7 mph (11 kph). In order to determine the LOS for each segment, it is necessary to estimate the demand volume under prevailing circumstances (V) for the chosen segments and convert it to the demand flow rate under corresponding base conditions (Vp). The average daily traffic volume was used to calculate the maximum PHV for each route.Due to the Iraqi transportation code, southbound (SB) traffic must use the right lane, while northbound (NB) traffic must use the left lane. As a result, both the northbound and southbound exits are labeled with the directional symbols (L-exit) and (R-exit), respectively. The geometry and volumetric input data for all directions of the selected roadway in the base case (2018), the near-term view (2023), and the intermediary case (2028) are presented in Tables 1, 2, and 3, respectively. The road between the Al- Dora and Al- Rashid interchanges is a rural four-lane divided highway. Every lane is 12.95 feet (3.95 m) wide, and the shoulders are 3.9 feet (1.2 m) wide in both directions.

The posted speed limit is 55 miles per hour (88 kilometers per hour). In Figure (3.9), we see the highway's current geometric cross section. Here are brief summaries of the six separate stretches of roadway. By increasing the cross-sectional width by 12 feet (3.6 meters) in each direction and 6 feet (1.8 meters) for the shoulder, the present geometric characteristics of the multi-lane roadway are improved. The roadway goes from being a continuous stretch of lanes to being separated into lanes by concrete walls. Therefore, as indicated in Figure (3.8), the multi-lane roadway is reduced to three lanes in each direction.

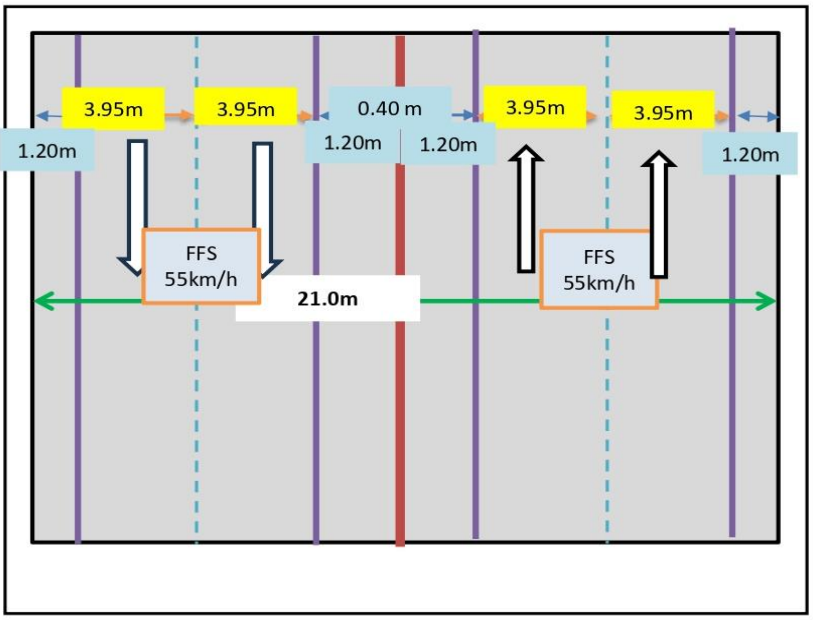

Figure 3.8: Cross-Section of the Existing Undivided Highway

The expansion of the multi-lane roadway into a freeway is now underway. So, a cloverleaf interchange joins the two remaining segments to make one longer one. As is evident in Figure (3.9), the first freeway highway segment connects the first three segments of the multi-lane highway, while the second freeway highway segment connects the fourth, fifth, and sixth portions of the multi-lane highway.

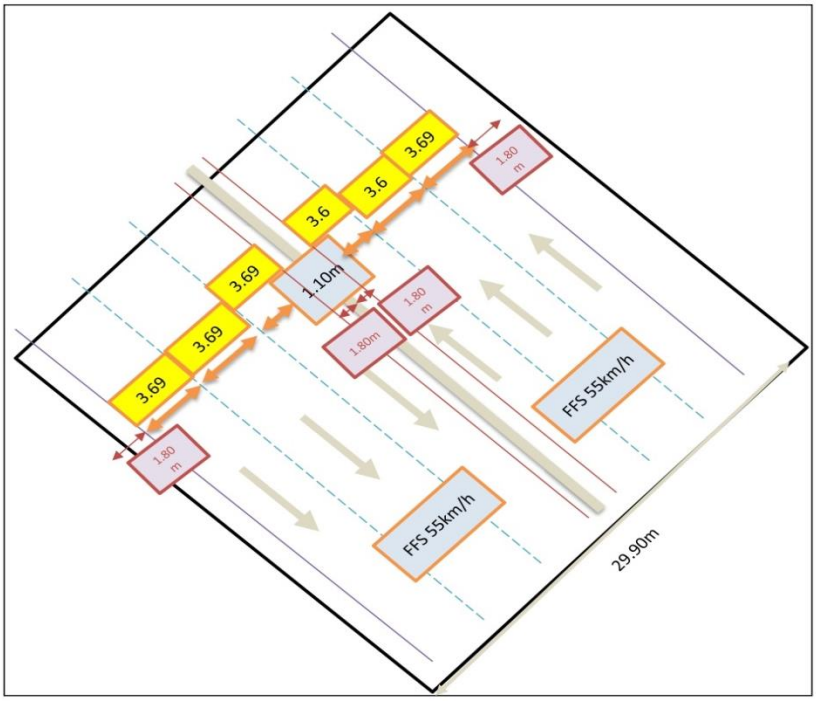

Figure 3.9: Proposed Cross-Sectional Diagram of the chosen Highway

Since the HCS- 2010 program is written in US units, all data is shown in both US and SI units. Each segment's length, peak hour traffic, percentage of grade, percentage of heavy trucks, access point density, lane width, stated speed limit, and includes the total amount of lanes in each direction.

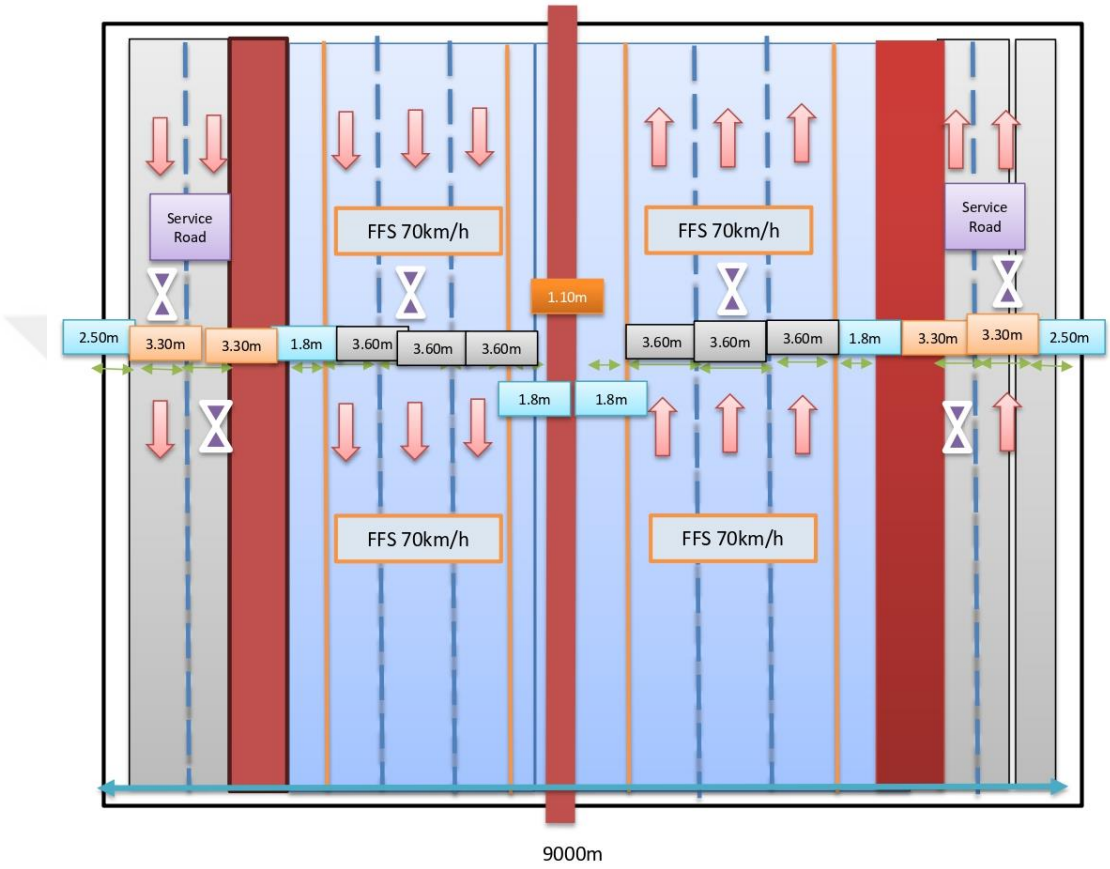

Figure 3.10: The Proposed Cross-Section for Segments 1 And 2 With One-Way Service Roadways for The Airport Expressway Freeway

Table 3.2: Causes of highway projects delayed in countries

Country	Average Project Duration (months)	Average Delay Time (months)	Major Causes of Delay
Iraq	24	12	Security concerns, political instability, financial issues
India	18	9	Bureaucratic red tape, land acquisition, financial constraints
USA	15	3	Environmental concerns, budgetary constraints
Brazil	20	7	Bureaucratic processes, environmental issues, corruption

Country: This column simply lists the names of the countries we are comparing.

Average Project Duration (months): This represents the typical time it takes for a highway project to be completed in that country from start to finish, assuming no delays. For instance, in our hypothetical scenario:

A highway project in Iraq would normally take 24 months (or 2 years) to complete.

In India, it would take 18 months.

In the USA, 15 months.

And in Brazil, 20 months.

Average Delay Time (months): This indicates the typical duration by which a highway project gets delayed from its original completion date. Using the table:

Projects in Iraq get delayed by about 12 months on average.

In India, they are delayed by about 9 months.

In the USA, the delay is about 3 months.

And in Brazil, projects experience an average delay of 7 months.

Major Causes of Delay: This column provides generalized reasons that most commonly lead to project delays in the respective countries.

In Iraq, the major factors are security concerns (due to the political situation and sporadic conflicts), political instability (changes in government, policies, etc.), and financial issues (lack of funds, budgetary constraints).

India faces delays mainly due to bureaucratic red tape (lengthy approval processes), challenges in land acquisition (getting the required land for projects), and financial constraints (lack of funds or budgetary issues).

In the USA, environmental concerns (ensuring projects don't harm the environment, which can lead to additional studies and changes) and budgetary constraints (lack of funds allocated for the project) are primary delay factors.

For Brazil, bureaucratic processes (slow approvals and permissions), environmental issues (protecting sensitive ecosystems), and corruption (misuse of funds, unethical practices) are common causes of delay.

Significance or New in Research

KMO (Kaiser-Meyer-Olkin) test, reliability analysis, and factor analysis. These statistical techniques are often used to assess the suitability of data for factor analysis, to measure internal consistency, and to identify underlying patterns or factors in the data, respectively.

KMO (Kaiser-Meyer-Olkin) Test:

Purpose: The KMO test measures the suitability of data for factor analysis. A high KMO value (close to 1) suggests that factor analysis is suitable, while a value below 0.5 suggests that factor analysis may not be appropriate.

Application in Project Delay Analysis: Before running factor analysis on project delay data (e.g., survey responses about reasons for delay), you would use the KMO test to determine if the data is suitable for such analysis.

Reliability Analysis:

Purpose: Reliability analysis, often using Cronbach's alpha, measures the internal consistency of a set of scale or survey items. A high Cronbach's alpha (typically above 0.7) indicates good internal consistency.

Application in Project Delay Analysis: If you have a questionnaire or survey about project delays, you'd use reliability analysis to ensure that the questions are consistently measuring the same underlying concept or construct.

Factor Analysis:

Purpose: Factor analysis identifies underlying patterns or factors in the data. It reduces a large number of variables into fewer dimensions or factors.

Application in Project Delay Analysis: After ensuring data suitability and reliability, you'd use factor analysis to identify the main underlying reasons for project delays. For instance, you might find that most delay-related variables load onto a few factors like "bureaucratic challenges", "financial constraints", and "environmental concerns".

New Process:

Gather Data: Collect data related to project delays, possibly using a survey or questionnaire.

KMO Test: Before diving into factor analysis, apply the KMO test to check if the data is suitable for factor analysis.

Reliability Analysis: Ensure the questions or variables have good internal consistency using Cronbach's alpha.

Factor Analysis: Conduct factor analysis to identify the main reasons or factors behind project delays.

Interpretation: Understand and interpret the factors. For example, if most of the delay-related variables load heavily onto a "financial constraints" factor, it indicates that financial issues are a predominant reason for delays in the projects.

Take Action: Based on the factors identified, stakeholders can take targeted actions to mitigate the reasons for delays.

Research Problem

1. **Problem Statement:**

Highway project delays in Iraq have become a recurring issue, leading to increased costs, prolonged completion timelines, and potential socio-economic repercussions for the nation.

2. Significance of the Problem:

Economic Impact: Delays often lead to cost overruns, affecting the national budget and potentially diverting funds from other critical projects.

Social Impact: Delayed highways can hinder the movement of goods and people, affecting trade, employment opportunities, and overall quality of life.

Security and Stability: Efficient infrastructure is vital for national security and stability. Delays might exacerbate existing security concerns or create new vulnerabilities.

3. **Objectives of the Research:**

Identify Causes: Determine the primary causes of highway project delays in Iraq.

Quantify Impacts: Measure the economic, social, and security impacts of these delays.

Recommend Solutions: Propose actionable strategies to mitigate these delays and their adverse effects.

4. Potential Causes to Investigate:

Political Instability: Changes in governance, policies, or priorities can affect project continuity.

Security Concerns: Ongoing conflicts or security threats can halt construction or divert resources.

Financial Constraints: Inadequate budgeting, unexpected cost overruns, or other economic factors can delay projects.

Bureaucratic Hurdles: Lengthy approval processes, land acquisition issues, or contractual disputes might cause delays.

Technical Challenges: The lack of skilled labor, machinery, or technical expertise can be a barrier.

Environmental and Social Concerns: Environmental impact assessments or concerns about displacement might delay projects.

4. DATA ANALYSIS & INTERPRETAITON

4.1 Introduction

In the preceding chapter, we have identified 185 numbers of Project variables related to the Construction of Substation Project in Iraq. These Project Variables were identified initially from literature reviews and then revisited and duly revised & modified utilizing the Nominal Group Technique. The Project variables were subsequently categorized based on Activity-wise Stakeholder-wise Work Break Down structure, developing into 20 such categories with allocation of the identified Project variables accordingly. In this chapter the Project variables which were categorized based on the Work Breakdown structure earlier are analyzed using Factor Analysis being part of the Objective – 1 of this study. For this, SPSS was utilized as a tool. As a consequence of the factor examination, those Project variables with an important factor loading were deemed significant. Upon identification of the significant Project variables, they were further utilized for the hypothesis testing using Chi-Square test to study the contingency perception of different stakeholders as part of the Objective - 2. For this testing, SPSS & excel spreadsheet were utilized as a tool. The test result has provided an insight of the various stakeholder perceptions on contingency estimation in construction of substations in Iraq. The following section of this chapter provides the process of analysis carried out by utilization of the methodology detailed in the Chapter -3 and provides the analytical outcome of the responses in the form of the Findings & Interpretation which were taken up for further utilization including the model formulation in subsequent chapter for this study.

Objective 1

The initial goal of the investigation was to identify, activity by activity, the significant Project variables influencing the contingency pertinent to substation construction in Iraq. In order to identify the significant Project variables, the list of Project variables derived as output at Chapter-3 along with the formulation of the

Questionnaire – 1 were considered as a basis here.While the list of Project variables was derived and was grouped into various categories, the questionnaire as formulated (Questionnaire Design / Sampling Technique / Sample Size) and detailed at Chapter – 3 was utilized for obtaining the responses from various professionals having experience in the field of construction of substations in Iraq; with the questionnaire having the 5-point scale as listed below. Upon identification of the significant Project variables, they were further utilized for the hypothesis testing using Chi-Square test to study the contingency perception of different stakeholders as part of the Objective - 2. For this testing, SPSS & excel spreadsheet were utilized as a tool. The test result has provided an insight of the various stakeholder perceptions on contingency estimation in construction of substations in Iraq. The following section of this chapter provides the process of analysis carried out by utilization of the methodology detailed in the Chapter -3 and provides the analytical outcome of the responses in the form of the Findings & Interpretation which were taken up for further utilization including the model formulation in subsequent chapter for this study.

Objective 1:

The initial goal of the investigation was to identify, activity by activity, the significant Project variables influencing the contingency pertinent to substation construction in Iraq. In order to identify the significant Project variables, the list of Project variables derived as output at Chapter –3 along with the formulation of the Questionnaire – 1 were considered as a basis here. While the list of Project variables was derived and was grouped into various categories, the questionnaire as formulated (Questionnaire Design / Sampling Technique / Sample Size) and detailed at Chapter – 3 was utilized for obtaining the responses from various professionals having experience in the field of construction of substations in Iraq; with the questionnaire having the 5-point scale as listed below:

1–Not Important; 2–Least Important; 3–Important; 4–More Important & 5–Most Important

The survey was distributed through both electronic mail and physical dissemination of printed versions. Participants were instructed to complete the questionnaire based on their relevant field of expertise and personal experience, as classified in the overarching Questionnaire 1. Filled out responses were received from the

respondents by means of e-mail with soft copy attachment, hand collected responses in hard copies; and few by means of filling out of questionnaire responses through telephone calls filled out manually. Table 4.1 below shows the completed responses received against each category of Questionnaire 1 sent.

Table 4.1: Summary of Responses received for Questionnaire 1

Sl. No.	Category	Number of Questions	No. of Questionnaire sent	No. of Completed Responses received
1	Finance	9	168	42
2	HR / Admin	14	152	56
3	HSEQ	20	160	65
4	Contracts	8	168	62
5	Design	15	170	61
6	Civil– General	8	163	67
7	Civil - Soil Investigation	2	163	67
8	Civil – Piling	8	163	67
9	Civil - Super structure	6	163	67
10	Civil – Finishing	8	163	67
11	Civil – External	7	163	67
12	MEP – General	8	157	59
13	MEP - Procurement / Manufacturing	6	157	59
14	MEP - Fabrication / Installation	7	157	59
15	MEP – Testing	7	157	59
16	ELEC – General	5	170	70
17	ELEC - Procurement / Manufacturing	6	170	70
18	ELEC – Installation	7	170	70
19	ELEC – Testing	15	170	70
20	Project Management	19	212	63

The responses as received were reviewed and are taken up for further analysis

4.2 Data Analysis

4.2.1 General response pattern

The Appendix A6 attached provides the detailed output of the responses received from various respondents indicating their importance as per the 5-point scale given against the Project Variables listed out in the Questionnaire 1; which are considered to have an impact on the contingency estimation for the project; duly summarized in the form of a table including all the completed responses against each Category wise – Project Variable wise results.

It was generally observed that the responses against the Project Variables follow the trend as discussed during the Nominal Group Technique; providing a minimal response towards negativity of their importance to the contingency estimation for the project; while there was a mixed response from various respondents towards their importance; be it a nominal or more or most.

These responses received against the categories are further analyzed using SPSS and the analysis is enumerated in subsequent sections below.

4.2.2 Reliability Testing by Cronbach's α (alpha)

The SPSS tool was utilized to analyze the reliability of the data (response) as received and tabulated in Appendix A6, taking each category of questionnaire 1 individually and applying Factor Analysis. The result as obtained from the Factor Analysis output related to the Cronbach's for each category are tabulated in Table 4.2. The above values of Cronbach' α are reviewed against the set criteria stated and detailed in the interpretation section.

Table 4.2: Summary of Cronbach' αResults

Sl. No.	Category	Number of Questions	No. of Completed Responses received	Cornbach's Alphan (Reliability)
1	Finance	9	42	0.703
2	HR / Admin	14	56	0.805
3	HSEQ	20	65	0.897
4	Contracts	8	62	0.793
5	Design	15	61	0.902
6	Civil – General	8	67	0.77

Table 4.2: (Cont.) Summary of Cronbach' αResults

Sl. No.	Category	Number of Questions	No. of Completed Responses received	Cornbach's Alphan (Reliability)
7	Civil - Soil Investigation	2	67	0.684
8	Civil – Piling	8	67	0.76
9	Civil - Super structure	6	67	0.743
10	Civil – Finishing	8	67	0.762
11	Civil – External	7	67	0.737
12	MEP – General	8	59	0.81
13	MEP - Procurement / Manufacturing	6	59	0.838
14	MEP - Fabrication / Installation	7	59	0.815
15	MEP – Testing	7	59	0.808
16	ELEC – General	5	70	0.724
17	ELEC - Procurement / Manufacturing	6	70	0.811
18	ELEC – Installation	7	70	0.812
19	ELEC – Testing	15	70	0.865
20	Project Management	19	63	0.895

4.2.3 Sample adequacy test [Kaiser-Meyer-Olkin Measure (KMO)]

The SPSS tools were utilized to analyze the Sample Adequacy of the data (response) as received and tabulated in appendix A6, taking each category of Questionnaire 1 individually and applying Factor Analysis to obtain the KMO values. The result as obtained from the Factor Analysis output related to the KMO Test for each category is tabulated in Table 4.3 below.

$$\boldsymbol{KMO} = \frac{\sum\sum \boldsymbol{r_{ij}^2}}{\sum\sum \boldsymbol{r_{ij}^2} + \sum\sum \boldsymbol{a_{ij}^2}} \quad \textbf{(4.1)}$$

rij is the correlation coefficient between variables i and j.

aij is the partial correlation between variables i and j.

The above values of KMO Measure are reviewed against the Values stated and detailed in the interpretation section.

Table 4.3: Summary of KMO Results

Sl. No.	Category	Number of Questions	No. of Completed Responses received	KMO (Sample Adequacy)
1	FINANCE	9	42	0.650
2	HR / ADMIN	14	56	0.704
3	HSEQ	20	65	0.783
4	CONTRACTS	8	62	0.770
5	Design	15	61	0.766
6	Civil – General	8	67	0.743
7	Civil - Soil Investigation	2	67	0.500
8	Civil – Piling	8	67	0.695
9	Civil - Super structure	6	67	0.709
10	Civil – Finishing	8	67	0.703
11	Civil – External	7	67	0.674
12	MEP – General	8	59	0.772
13	ME- Procurement/ Manufacturing	6	59	0.818
14	MEP - Fabrication / Installation	7	59	0.721
15	MEP – Testing	7	59	0.770
16	ELEC – General	5	70	0.684
17	ELEC-Procurement/ Manufacturing	6	70	0.797
18	ELEC – Installation	7	70	0.805
19	ELEC – Testing	15	70	0.727
20	PROJECT MANAGEMENT	19	63	0.817

4.2.4 Factor analysis for identification of significant project variable

The SPSS tool was utilized to carry out the Factor Analysis for identification of Significant Project variables from the compiled list of 185 Project Variables as given in the Questionnaire 1. The loadings in the Rotated Component Matrix for each category wise Project Variable were taken up for identification of their significant. The summary of output report of the Factor Analysis carried out is tabulated in Table 4.4 below while the complete Factor Analysis report for the data as received is attached as Appendix A7. This analysis report was reviewed and the findings are detailed in the interpretation section.

$$X = \mu + LF + \epsilon \quad \textbf{(4.2)}$$

X is the matrix of observed variables.

μ is the mean of the observed variables.

L is the matrix of factor loadings, which represents the relationship between observed variables and the latent factors.

F is the matrix of latent factors.

ϵ is the matrix of unique variances (errors) for each observed variable.

Table 4.4: A Brief Report on the Results of Questionnaire 1's Factor Analysis

Summary Of Factor Analysis Output For Questionnaire 1 (Objective 1)							
Categories	**No. of Initial Questions**	**No. of Response**	**Cornbach's Alphan (Reliability)**	**KMO (Sample Adequacy)**	**Determinant**	**Total Variance Explained %**	**No. of Variables above 0.700 value of factor loading**
Finance	9	42	0.703	0.650	0.037	68.522	6
HR / Admin	14	56	0.805	0.704	0.007	61.270	5
HSEQ	20	65	0.897	0.783	9.38E-06	66.983	9
Contracts	8	62	0.793	0.770	0.099	55.273	5
Design	15	61	0.902	0.766	0.00E+00	61.705	8
Civil – Gen	8	67	0.770	0.743	0.106	56.438	5
Civil - Soil Inv	2	67	0.684	0.500	0.728	76.095	2
Civil – Piling	8	67	0.760	0.695	0.097	70.001	8
Civil - Super strut	6	67	0.743	0.709	0.24	62.683	4
Civil – Finishing	8	67	0.762	0.703	0.052	60.405	5
Civil – External	7	67	0.737	0.674	0.196	57.356	4
MEP – General	8	59	0.810	0.772	0.069	58.586	5
MEP - Proc / Mfg.	6	59	0.838	0.818	0.085	56.411	4
MEP - Fab / Inst	7	59	0.815	0.721	0.055	65.144	5
MEP – Testing	7	59	0.808	0.770	0.078	63.115	6
ELEC – General	5	70	0.724	0.684	0.31	70.326	5
ELEC - Proc / Mfg.	6	70	0.811	0.797	0.109	70.057	5
ELEC – Inst	7	70	0.812	0.805	0.106	63.344	4
ELEC – Testing	15	70	0.865	0.727	0.00E+00	70.724	8
Project Management	19	63	0.895	0.817	4.16E-05	61.809	5

4.3 Findings & Interpretation

4.3.1 Reliability test

Cronbach's Alpha was a method invented by Lee Creonbach in 1951 (Mohsen, Reg; 2011) that was used to evaluate the consistency of results. Cronbach's Alpha, also referred to as "Cronbach's," is the average value of the dependability co-efficient calculated for all conceivable combinations of the provided items. Cronbach's Alpha may also be abbreviated as "Cronbach's." According to Anil (2012), it is computed to ensure that there is internal consistency and dependability. As a Matter of Theory, the value of alpha may range anywhere from zero to one, with one being the ratio of the two possible values.

It is noteworthy that alpha estimates are not constrained to a specific range, as they can assume any value below or equal to 1, even negative ones. Nevertheless, it is important to acknowledge that solely positive values are meaningful in this context. The range of potential values for alpha is determined by the utilized estimation methodology. When it comes to dependability, higher alpha values are preferable wherever possible. Before using the data as an instrument for analysis, the majority of the analyses need a reliability of 0.70 or above, which must be established on a sizeable sample. This serves as a rule of thumb. However, in order to prevent redundant information from being collected, it has been suggested that the maximum alpha value should not exceed 0.90. The distribution of Cronbach's alpha and its corresponding analysis can be observed in the diagram denoted as "table "4.5.

$$\boldsymbol{\alpha = \frac{K}{K-1}\left(1 - \frac{\sum_{i=1}^{K} \sigma_{Y_i}^2}{\sigma_X^2}\right)} \qquad \textbf{(4.3)}$$

Table 4.5: Cronbach's Alpha Reference Value

Cronbach's alpha	Internal consistency
$\alpha \geq 0.9$	Excellent
$0.9 > \alpha \geq 0.8$	Good
$0.8 > \alpha \geq 0.7$	Acceptable
$0.7 > \alpha \geq 0.6$	Questionable
$0.6 > \alpha \geq 0.5$	Poor
$0.5 > \alpha$	Unacceptable

Source: (Wikipedia)

Internal consistency i.e., reliability should be determined before a test can be employed for further examination or research to ensure its validity. The result obtained shows that for all the categories in the questionnaire, the alpha value is between 0.684 and 0.902. On detailed examination, it has been distinguished that the lower Cronbach's Alpha value of 0.684 has been achieved in the category "Civil – Soil Investigation" due to only two Project Variables are included. Since this value was nearer to 0.700 and has been considered acceptable in general, the result for this category was considered for further analysis.

Furthermore, the Cronbach's Alpha value of all other categories was in the Acceptable range (0.700 to 0.900) and hence was also considered for further study.

4.3.2 Sample adequacy test [Kaiser-Meyer-Olkin Measure (KMO)]

The appropriateness of the sample is determined by KMO, which stands for Kaiser-Meyer-Olkin. The KMO Test is an essential component of the results that are generated by the SPSS program when factor analysis is carried out; the KMO statistic might range from 0 to 1, depending on the results. The presence of diffusion within a sequence of correlations can be inferred when a value of '0' is observed, as evidenced by the substantial sum of the partial correlations relative to the overall correlations. A number that is near to '1' implies that the pattern of correlations is generally compact, and as a result, factor analysis ought to generate discrete and trustworthy components.

According to Kaiser (1974), an appropriate number would be one that is more than 0.5. The range of possible KMO values, as well as their interpretation of those values, are shown in the following figure: Table 4.6:

Table 4.6: KMO Range

KMO Value	Degree of Common Variance
0.90 to 1.00	Marvelous
0.80 to 0.89	Meritorious
0.70 to 0.79	Middling
0.60 to 0.69	Mediocre
0.50 to 0.59	Miserable
below 0.50	Unacceptable

Source: (Kaiser (1974))

The Sample Adequacy should be determined on the response for each category before the data can be utilized for Factor Analysis. The result obtained shows that for all the categories in the questionnaire, the KMO values are between 0.500 and 0.818, which fall into the acceptable range. Thus, it can be inferred that the utilization of factor evaluation has been deemed suitable for the aforementioned data. On detailed examination, it has been distinguished that the lower KMO value of 0.500 has been achieved in the category "Civil – Soil Investigation" due to only two Project Variables are included. Since this value is 0.500 and has been considered acceptable in general even though being termed as "Miserable", the data obtained for this category has been considered for Factor Analysis. Furthermore, the KMO value of four categories are between 0.650 and 0.695 which falls under the "Mediocre" range; while 12 categories are between 0.703 and 0.797 which falls under "Middling" range and three categories are between 0.805 and 0.818 which falls under "Meritorious" range. Since the result as obtained are in the Acceptable range as per above stated criteria, the data as obtained from respondents are confirming to the sample adequacy and were taken up for further analysis.

4.3.3 Factor analysis for identification of significant project variable

The primary requirement for carrying out the Factor Analysis was to identify the significant Project Variables relevant to the field of Construction of substations in Iraq based on the responses received against the Questionnaire 1 having set of questions related to activity wise breakup as 20 numbers of categories, which are grouped together for the relevant stakeholders. According to the Table of Loadings for Practical Significance (p112) by Hair et al. (1998), variables that exhibit a factor loading exceeding 0.7 may be deemed to possess practical significance in the SPSS output, as illustrated in table 4.7.

Table 4.7: Table of Loadings for Practical Significance

Factor Loading	Sample Size needed for significance
0.30	350
0.35	250
0.40	200
0.45	150
0.50	120
0.55	100
0.60	85
0.65	70
0.70	60
0.75	50

Source: (Hair et al. (1998)

Accordingly, the Factor Analysis output against each category as obtained and attached at was taken up for detailed interpretation to identify the variable which are having factor loading of more than 0.7.The matrix denoted as the rotated component matrix, alternatively referred to as the rotated factor matrix in the context of factor analysis, represents the factor loadings of every variable onto each factor. The present matrix retains exactly the same data as the component matrix, albeit computed subsequent to rotation. Prior to rotation, the majority of variables exhibited a strong loading on the initial factor, with the subsequent factors receiving minimal consideration. The process of rotating the arrangement of factors has significantly enhanced the clarity of the matter at hand.Based on the above, the Project Variables were identified and were considered as significant based on their factor loading value of above 0.700. The abstracted significant Project variables as identified are attached as Appendix A8. The above identification had resulted in a total of 108 Project Variables across the 20 categories which are further taken up as part of the Questionnaire2, enabling to proceed further with Objective 2 of this study.

Objective 2:

The secondary aim was to examine the perception of contingency among diverse stakeholders with respect to the prominent Project variables ascertained in the first objective, and their influence on the project's efficiency in constructing substations in Iraq, specifically in terms of time and expense.

To obtain the Contingency perception of the stakeholders for the identified significant Project variables in various categories, the Questionnaire 2 was

formulated with the following Questionnaire format & scale for obtaining response, as given in Table 4.8 below:

Table 4.8: Format & Scale for Obtaining Response of Questionnaire 2

SL. No	Project Variable	Details	Very Low	Low	Moderate	High	Very High
1		Probability	☐	☐	☐	☐	☐
		Cost Impact	☐	☐	☐	☐	☐
		Time Impact	☐	☐	☐	☐	☐

The respondents were requested to provide their responses for each significant variable for Probability of occurrence of the significant Project variable and its Cost Impact and Time Impact. In order to have a common platform for the response, a reference table showing the range of Probability, Cost Impact and Time Impact for the above 5-point scale was provided as shown in table 4.8. The Table 4.9 below shows the completed responses received against each category of Questionnaire 2 sent.

Table 4.9: Summary of Responses Received for Questionnaire 2

Sl. No.	Category	Number of Qtns.	No. of Questis. Sent	No. of Responses recd.
1	Finance	6	168	50
2	HR / Admin	5	152	43
3	HSEQ	9	160	47
4	Contracts	5	168	59
5	Design	8	170	53
6	Civil – General	5	163	48
7	Civil - Soil Investigation	2	163	48
8	Civil – Piling	8	163	45
9	Civil - Super structure	4	163	48
10	Civil – Finishing	5	163	48
11	Civil – External	4	163	48
12	MEP – General	5	157	46

Table 4.9: (Cont.) Summary of Responses Received for Questionnaire 2

Sl. No.	Category	Number of Qtns.	No. of Questis. Sent	No. of Responses recd.
13	MEP - Procurement / Manufacturing	4	157	46
14	MEP - Fabrication / Installation	5	157	46
15	MEP – Testing	6	157	46
16	ELEC – General	5	170	60
17	ELEC - Procurement / Manufacturing	5	170	60
18	ELEC – Installation	4	170	60
19	ELEC – Testing	8	170	60
20	Project Management	5	212	56

This Questionnaire # 2 was sent out by means of e-mail and hand delivery of the hard copies to all the respondents as done during Questionnaire 1. The respondents were once again requested to fill out their response which was relevant as categorized in the overall Questionnaire 2. Filled out responses were received from the respondents by means of e-mail with soft copy attachment, hand collected responses in hard copies; and few by means of filling out of questionnaire responses through telephone calls filled out manually. The responses as received were reviewed and are taken up for further Hypothesis testing as required in the Objective 2.

4.4 Data Analysis

4.4.1 General response pattern

Appendix A9 provides the detailed output of the responses received from various respondents indicating perception based on their experience of the Probability of Occurrence and their Impacts on Cost and Time, of the identified Significant Group of Project Variables for the Substation Construction works in Iraq. These Project variables are considered to have an impact on the contingency estimation for the project; duly summarized in the form of a Table including all the completed responses against each Category wise – Project Variable wise results.It is generally observed that the responses against the Project Variables follow the trend of lenience towards the Moderate to High levels of occurrence and their impact. These responses

received against the categories are further taken up for Hypothesis testing and the analysis output is enumerated in subsequent sections below.

4.4.2 Hypothesis testing

An assumption regarding a population variable is what statisticians refer to as a statistical hypothesis. This presumption might or might not turn out to be accurate. Testing a statistical hypothesis is a formal technique statisticians follow to decide whether or not to accept or reject a statistical hypothesis. Examining the entirety of the population is the most reliable method for establishing whether or not a statistical hypothesis is accurate. Researchers often analyze a random sample taken from the population rather than the entire population as a whole because doing so is sometimes impracticable. If the results from the sample do not support the statistical hypothesis, then the hypothesis will be deemed to be false.

There are two types of statistical hypotheses.

The null hypothesis, also known as H0, is the idea that sample observations are the product of nothing more than random chance. It is typically referred to as the null hypothesis.

The hypothesis that sample observations are impacted by some non-random source is referred to as the alternative hypothesis and is marked by the letter H1.

For the purpose of deciding whether or not to reject a null hypothesis on the basis of sample data, statisticians follow a systematic approach. This method, which is also known as hypothesis testing, is comprised of the following four steps: Create a plan and do an analysis, analyze sample data and Interpret outcome.

In this study, the Hypotheses stated as below:

****

H0 (Null Hypothesis)

The perspective of the stakeholder with regard to contingency and project performance are not significantly related.

H1 (Alternate Hypothesis)

The perspective of the stakeholder with regard to contingency and project performance are significantly correlated.

****

Within the scope of this hypothesis, we are working with a single population and two category variables. The technique of sampling that is used in this research is a random sampling method. The two categorical variables that are being assessed independently are "Probability of Occurrence" and project performance in terms of "time" and "cost." A random sample strategy was chosen as the sampling technique in this investigation. According to Zulfiqar Ali and S. Bala Bhaskar (2016), there are three different types of tests (or tools) that may be used to conduct an analysis of categorical or nominal variables. These variables constitute a component of this research, as was previously mentioned. The Chi-square test, McNemar's test, and Fischer's exact test are the three possible options. The frequencies are compared using the Chi-square test to examine if there is a statistically significant distinction between the observed data and the data that would have been expected if there had been no distinctions between the groups (the null hypothesis). It is computed by taking the total of the squared differences between the data that was observed (O) and the data that was anticipated (E), also known as the deviation (d), and dividing that number by the data that was predicted:

It is possible to establish whether or not there are non-random connections between two category variables by using Fischer's exact test. It does not make the assumption that samples were selected at random, and rather of referring a computed statistic to a sampling distribution, it computes an exact probability. For paired sets of nominal data, McNemar's test is used. It is used on a table with paired-dependent samples with a dimension of 2 by 2. It is used to assess if the row and column frequencies are equal, or whether there is ‘marginal homogeneity' in the data. It is assumed under the "null hypothesis" that each pair of proportions has the same value. According to Mary L. McHugh's (2013) assertion, the Chi-square test of independence, also referred to as the Pearson Chi-square test or simply Chi-square, is a highly valuable statistical tool for hypothesis testing in cases where the variables under consideration

are nominal. Thus, the Chi-square statistical analysis was employed in the present investigation.

The data as collected from the Questionnaire2 response as stated above were taken up for the analysis in the following sequence:

a) Hypothesis testing using Chi-Square test (using SPSS for 95% confidence level)

b) Hypothesis testing using Chi-Square test (using Excel spreadsheet for 95% & 99% confidence levels).

For the above received data Crosstabs using SPSS was applied while manual calculation with formula were utilized in Excel Spread sheet for 95% & 99% confidence levels. The SPSS output and the Excel Spreadsheet output is summarized and attached as Appendix A10.

The detailed interpretation of the output is provided in the subsequent section.

4.5 Findings & Interpretation

The process of hypothesis testing was executed on the data procured from diverse stakeholders in order to determine the presence of a noteworthy correlation between stakeholder opinion of the contingency and the success of the project.

4.5.1 Hypothesis testing using chi-square test (Using SPSS)

The SPSS output of the Chi-square test as obtained was reviewed for all the 108 numbers of Significant Project Variables for which the data was collected from various respondents. The review was also done verifying the Chi-square result for “Probability & Cost Impact” and “Probability & Time Impact”, which reflects the project performance.

The result obtained for all the Project Variables across the categories, shows that the Chi-Square value as obtained in the SPSS output are over and above the theoretical value based on their Degree of Freedom (95% confidence level).

The output suggests that the “H0 Null Hypothesis” can be rejected in favor of the “H1 Alternate Hypothesis” for all the 108 number of Significant Project Variables that were taken up for this Objective 2. The same has been stated in the Appendix A10.

4.5.2 Hypothesis testing using chi-square test (using excel spreadsheet for 95% & 99% confidence levels)

The Excel spreadsheet output of the Chi-square test as obtained was reviewed for all the 108 Nos of Significant Project Variables for which the data was collected from various respondents. The review was also done verifying the Chi-square result for "Probability & Cost Impact" and "Probability & Time Impact", which reflects the project performance with 95% confidence level & 99% confidence levels. The result obtained for all the Project Variables across the categories, shows that the Chi-Square value as obtained in the Excel spreadsheet output are over and above the theoretical value based on their Degree of Freedom with both 95% confidence level & 99% confidence levels. The Excel spreadsheet output with 95% confidence level was also reviewed with the related SPSS output for all the significant variables as a point of rechecking and both the results found to be same. Thus, the result obtained suggests that the "H0 Null Hypothesis" can be rejected in favor of the "H1 Alternate Hypothesis" for all the 108 number of Significant Project Variables that were taken up for this Objective 2. The same has been stated in the Appendix A10.

4.6 Chapter Summary

The significant Project Variables related to the Construction of Substation project in Iraq are identified as part of the Objective 1. Factor Analysis was applied to the overall 185 Nos. of Project Variables (which were grouped into 20 Nos of categorized based on Activity-wise Stakeholder-wise Work Break Down structure), duly filtering out the Project Factors which are having considerable factor loading. As a result of the factor analysis and the obtained factor loading for the individual Project Variables, 108 Nos. of Significant Project Variables across the 20 Nos. of categories were identified. The Reliability of the data received from the respondents was verified using the Cronbach's Alpha ($\boldsymbol{\alpha}$) value obtained from the SPSS output as part of the Factor Analysis for each Category shows that the data as received are in the Acceptable range. The Sample Adequacy test by Kaiser- Meyer-Olkin measure (KMO Test) for each category was done using SPSS and found the result to be within the Acceptable criteria. Thus, the Reliability and Sample Adequacy confirmation provide that the Objective 1's output as obtained from the Factor

Analysis resulting into 108 Nos. of Significant Project Variables across 20 Nos. of Categories are suitable to be taken up further for study as required for Objective 2.

These identified Significant Project Variables obtained as output from the Objective 1 were taken up to study the contingency perception of different stakeholders as part of the Objective2. Hypothesis testing using Chi-Square test with both SPSS (for 95% confidence level) & Excel spreadsheet (for both 95% & 99% confidence level) were done and the result confirms the perceptions on contingency estimation in Construction of substations in Iraq as below:

****

H1 (Alternate Hypothesis)

There is significant relationship between the perception of the stakeholder pertaining to contingency on project performance.

****

Since the result confirms to the Alternate Hypothesis, the data as obtained as part of the Objective 2 are taken up for further utilization for formulation of the Contingency Estimation Model in subsequent chapter of this study. This chapter provides the validation of the Research by concurring to the significant relationship between the perception of the stakeholders pertaining to the contingency on the project performance, which initiates the next step of this study, towards the process required for the formulation of a model for the contingency estimation and subsequent validation of the formatted model based on the Historical data obtained from earlier executed substation construction project in Iraq. Road Construction work is a dangerous occupation that takes place on land. The importance of health and safety precautions in the construction industry cannot be overstated. In point of fact, concerns about health and safety must be given top attention in every facet of the building industry. The construction sector is fraught with a significant number of hazards and possibilities for accidents. Materials, equipment, and machines used in construction each come with their own set of inherent dangers. On construction sites, the most common causes of death or severe injury are collisions, mishaps involving worksite vehicles, and material collapses that cause delays in project completion. These are the three most common forms of deaths. The research study that included

the findings of the framework analysis provided the following recommendations with regard to problems concerning worker safety.

Your company, from the CEO on down, must hold a commitment to safety as one of its most important core values, and the top management team has an obligation to set an example by actively engaging in safety meetings and workshops. Utilizing safety councils that include both managers and site employees is one method that has the potential to be both efficient and successful in terms of enhancing safety. However, if the workload is substantial enough to warrant it, the budget should also contain funds for an internal safety manager. This has the effect of making safety an essential component of the job. Your company, from the CEO on down, must hold a commitment to safety as one of its most important core values, and the top management team has an obligation to set an example by actively engaging in safety meetings and workshops. During the process of planning the project, a job safety analysis should be performed for each component of the project. This should be done to ensure that proper precautions are taken before any work is started. As part of the planning process for the project, it will make sure that everyone is safe. Employees should be given training on how to utilize safety equipment, potential safety hazards, safety expectations, and safety measures specific to the activities they do. The development of accountability at all levels should be systematically enforced, and it should be expected of all staff members that they will take some amount of ownership for the safety and security measures taken. It is important to evaluate the level of safety performance shown by any possible subcontractors as part of your procurement process. This would entail conducting an audit of the security management system as well as the assessment of the road. Therefore, the contractors have taken precautions to ensure safety. In order to further enhance overall safety, routine field security checks are carried out. Checks may identify potential security hazards, such as utilized and worn-out equipment, dangerous behaviors, or instruments that are improperly situated, and provide you the chance to address these issues before they lead to an accident. One of the most common ways people get injuries and sometimes lose their lives is through falling from a great height. You need to make sure that your drop protection program is working properly by having a detailed fall management strategy for each and every project that has the potential for a fall occurring. Verify that you have procedures in place regarding alcohol and

drugs to prevent those who are impaired from finding employment there. Because of this, there won't be any drug misuse in the job. Be sure that the topic of safety is brought up during job changes, weekly meetings, and any other time when shifts are changed. This guarantees that discussions on safety are a regular occurrence. to conduct an investigation and utilize the necessary information to improve safety measures in order to uncover the fundamental reasons behind all accidents and near misses in order to forestall the occurrence of such occurrences in the future. When working on projects involving roads and highways, the following steps should be performed to increase communication amongst the participants in the project. Sending messages in a variety of different methods can help ensure that they are understood correctly. Establish a command chain and communication links that are suitable for the messages and information. It is essential to use project management software that has been kept up to date in order to connect with all devices. Make use of document tracking software to keep track of modifications across all phases of the project and with all stakeholders. Maintain proper grammar, steer clear of colloquialisms, and make sure that what you write is clear, uncomplicated, and easy to read. Whether we are talking about architects, contractors, or construction workers, everyone who has an interest in the project is worried about feedback. Make sure that the feedback is understood in both directions, and follow up on it on a regular basis. Ongoing training on new pieces of hardware, software, and apps; security and regulatory updates; and best on-site and off-site practices for project management. The decision to work with skilled workers and contractors makes efficient communication throughout the full team simpler and more manageable. Be sure that even in very distant areas, there is access to the appropriate linkages and networks that are functioning properly. Find out whether or if a second or third language is required, and examine the ways in which it is employed specifically for safety and logistics.

Management of Disputes That Is Friendly

The biggest causes of conflict amongst project teams include disagreements over project aims, disagreements regarding project priorities, and conflicts regarding work hours. Personality and interpersonal issues may also contribute to conflict, which is particularly prevalent in high-tech circles, which are characterized by cross-

functional and self-managed teams whose members come from highly technical backgrounds and must depend on the work completed by others. In order to lessen the likelihood of their being a disagreement, it is essential that each and every aspect of the building process be perfected at each level. The construction contract serves as the foundation for the dispute resolution procedure, which begins with defining the disagreement provisions. During the planning and carrying out of the project, additional preventative measures such as the following should be taken into consideration: The research study, which included the findings of the framework analysis, made the following recommendations with regard to concerns concerning land acquisition difficulties. Take your time to read the contract and make sure you understand it. Before beginning work, extensive advance preparation should be done. Discuss and negotiate any clauses that are unclear or might possibly cause problems. Increase the amount of information that is transparent to all of the parties involved in order to detect hazards and consult with experts in advance. When working on the pre-construction phase of a project, such as preparing budgets and timelines, contacting subcontractors, placing crucial orders, etc., use extreme caution. addressing issues as they crop up, rather than putting off dealing with them; 158 The importance of resolving conflicts in real time is emphasized. The amicable settlement of a disagreement may save enormous amounts of time and money. Record the most significant issues and difficulties that arose throughout the implementation. Maintaining command over consistently shifting priorities Set up regular review sessions so that communication may be improved and any misconceptions about the project's goals and priorities can be cleared up. Encourage a mutual respect atmosphere. No form of conflict resolution will be successful unless both parties respect one another and are willing to respectfully disagree while still working to address their differences. Foster an atmosphere of mutual respect within the social setting. If there is no mutual respect and no willingness to compromise and find a solution to disagreements, then there is no way of conflict resolution that will be successful. Team members should be trained in soft skills, and more active participation should be encouraged in team building activities.

Availability of Construction Materials

The contractor is obligated to arrange the essential materials and equipment for the execution of a project within a time restriction. Availability of construction materials is a requirement. It is possible that the delayed completion of a project will be the result of a shortage of essential materials or equipment, as well as their scarcity. Rather of using alternative or recycled resources, road building projects make use of this natural rock material. Materials such as recycled glass, metal, plastic, and wood may be used to totally or partly replace aggregate, shattered rock, sand, and gravel. The alternative material has the potential to become a future source of waste products in both the home and industrial settings. These materials are easily accessible and don't cost much. In addition, the use of these materials in the building of roadways provides an effective means of resolving the associated issues of pollution and waste disposal. 159 The following types of waste materials are used in the building of roadways: plastic waste materials, packaging waste, industrial ash (both bottom ash and fly ash), and industrial ash. In the hot mixing plant, the combination of waste plastic with bitumen and thin bits of stone will give extra protection against the water that is produced by rainfall, which will ultimately result in an increase in durability. In lieu of aggregate, which is typically used in asphalt concrete flooring, several road authorities routinely approve the use of glass in its stead. Glass that has been recycled may serve as an adequate substitute for rocks. It is most often used as material for embankments. The foundation material may include crushed glass if the Contractor so chooses. Steel slags and blast furnace slags are two examples of these types of materials. Glass. Byproducts of coal ash, such as fly ash, bottom ash, and others Carpet Fibers. Roofing Shingles Are Thrown Away. Rubber Tires. Plastic that has been reused. Ash produced by the combustion of municipal solid waste. The majority of these analyses were carried out in the laboratory. It is required to run a systematic program to apply these concepts in order to evaluate whether or not these materials are practical and how they function in real road construction projects.

Avoiding Design Changes

The road building business has a significant challenge with regard to change management. The significant amount of work that was put in to handle the modifications imposed a significant load on the project. It is widely acknowledged

that the primary reason for a project's delay, cost overruns, or even cancellation is the presence of frequent modifications. Even more dangerously, the industry as a whole is plagued with major ethical concerns and disagreements because of frequent project revisions. It has come to our attention that the lack of expertise had by the consultant is tied to this problem. Due to the fact that these alterations were not previously accounted for, the contractor may have difficulties in constructing the building or organizing the budget when the consultant makes modifications to the design. In addition, failing to accurately anticipate the expenditures of the project may cause the customer to pull out of the arrangement since he is unable to meet any more financial obligations. As a consequence of this, a delay in approvals by the consultant might create a delay in the pace of work, which in turn causes a delay in the time it takes to finish the project. The following table provides a summary of the causes, effects, and recommended courses of action regarding changes in construction.

4.7 Concluding Remarks

There are three distinct analyses: one for the customer, one for the consultant, and one for the contractor. The Relative Importance Index (RII) was used in the data analysis and ranking procedure. Five-point significance scales were used to rate the various causes of the delay. Twenty participants were sampled across all groups for pilot testing, and the instruments' reliability was established by Cronbach's alpha. In order to streamline the investigation and classify the variables into meaningful groups, factor analysis was used. There were three distinct phases of analysis: client, consultant, and contractor. KMO and Bartlett tests were used to ensure sufficient sample size, indicating that the variables are dependent and correlated on one another as required for factor analysis. In order to quantify the unique effect of the delay produced by PCFA variables, a multiple regression analysis has been conducted. When doing a regression analysis, the coefficient is the percentage change in the dependent variable for a change of one in the independent variables.

5. CONCLUSION

5.1 Overview

In this chapter, we give the final framework's principles for reducing project delays in Iraq's roads and highways sector. Project delays may be avoided with the help of the detailed explanations provided in the guidelines. The chapter details the most important considerations for putting the framework into action.

5.2 Framework Guidelines to Mitigate Project Delays

The following guidelines emerging from framework are suggested to overcome these challenges and maintain the projects on track.

Automated Work Permits

Permits for work are a formal process for managing hazardous jobs. Such actions may be carried out by authorized personnel under the terms of a permission, in accordance with established standards documents. Government rules in awarding construction licenses may slow down the progress of public road projects. In order to do the required work, the contractor must first get the necessary permissions from the appropriate government agencies. Work permits are issued by these governmental entities in accordance with their particular set of guidelines. Getting these permissions may be a huge hassle for contractors, and it often causes delays in construction. Notification of the impending need for a work authorization is recommended since the issue of work permits may be a time-consuming and difficult procedure. Work system approval does not improve safety; only following the right procedures will accomplish that. Therefore, it is crucial that systems be not just checked off a list but rather thoroughly discussed at site inductions, as well as regularly monitored, analyzed, and updated.

As per interaction with experts, permit to work system should:

- Consider whether any other work will affect the authorized work or be affected by it.
- Ensure monitoring and monitoring measures are in place. Only allow authorized and competent staff to issue permits. Provide other parties affected by the work with information. Provide statements of methods and emergencies.
- Prevent high-risk work without undertaking any risk assessment. Include a return and cancelation permit system.
- Ensure that the work is checked and re-established.

Implementing E- Permits - automated Permit Control process

All of your company's active licenses are kept in a secure database managed by a computer program. The review and approval procedure are monitored via the use of documentation that is absolutely necessary for acquiring and renewing licenses. In order to prevent expensive repercussions like fines and sanctions for expired work permits, it is essential to keep track of them. Compliance with regulations from issuing authorities like the EPA and OSHA may be monitored by automating your EHS's authorization control operations. Your organization may ensure that all permits are always on hand and up to date and that compliance is always met by defining due dates and allocating duties

Settling Progress Payments

A payment for progress is a kind of partial payment used in the construction industry to compensate workers for their efforts so far. The inability to allocate funds to other priorities may cause a halt in interim payments. Since there is no funding for the project, it will remain a paper project with no action taken. Some contractors saw a decrease in available funds because of staffing issues. The contractor's financial stability may be jeopardized if it had to come up with more money to buy supplies and other goods, which would slow progress on the project and extend its completion date.

Most respondents believed that delayed payments may be avoided or reduced by using contractual or statutory rights. It has been discovered that late payment interests or overdue fees are seldom applied in the construction business. In order to ensure and promote a balanced risk distribution and a totally fair contract for all linked parties, professional boards and government agencies should review and revise the current standard contract terms. Since conflicts were often settled by arbitration or litigation, this was also a less probable option.The findings and recommendations of this study must be addressed by all relevant parties in the road construction business in order to effectively solve the problem of late payments.

That requires:

- Employers should be required to disclose their financial capability and credit rating to their contractors in order to increase the likelihood of contractors getting paid.
- Transparent financial capacity and credit ratings of employers should be required in order for contractors to choose reliable employers and increase chances for payment to a contracting company.
- Establish payment departments to document contractor payment delays. This service would keep track of each client's individual payment history, including any overdue amounts. If these clients do not make their payments as agreed upon, they might face consequences. Time is of the essence, and the division should be able to find solutions to issues promptly.
- Contract payment delay clause enforcement. Service costs for late payments might be determined in a manner similar to how late delivery fees are calculated.

Dealing With Land Acquisition Issues

- Since acquiring land is often perceived as controversial, a methodical, open, and compassionate strategy is required to ensure a smooth transition. Because the property being bought is often the source of income for the landowners, it is imperative that their interests be protected during the acquisition process. In order to lessen the burden on the affected projects and people, a reasonable compensation plan for land, relocation, and rehabilitation must be crafted.

- The following are some solutions to land acquisition challenges that have been suggested by the research after taking into account the inputs from the framework analysis. LARC and Super LARC in the event that the projected cost is too high for the property.
- If the landowners are willing to sell outright after considering all other options, the price should be determined by competitive bidding starting at a price that the landowners would consider to be fair. The government's role, if any, should be limited to that of a facilitator at most. The landowners should be approached with an offer of a lengthy lease or stock in the prospective business in exchange for the property. In either scenario, land ownership would be respected. The same arrangement should hold true even in publicly financed initiatives. This choice ensures that impacted households will have a reliable source of income.
- Governments' responsibilities should be limited to making sure the rights of property owners are adequately protected. Government must find a middle ground between expansion and landowner interests if it is to serve the public interest.
- Within two months of its formation, an impartial expert committee must propose whether or not to acquire a specific parcel of property for public use.
- The authority of governments to acquire private property should be restricted by legislation. Based on the findings of the research, it is clear that politicians and public servants often acquire and waste more land than is required for public uses.

Ensuring Manpower Safety

- Road Land-based construction activity is dangerous. In the construction industry, health and safety are top priorities. Safety and health must be top priorities at every step of the building process. There are a lot of risks and opportunities for accidents in the construction sector. There are risks associated with using any construction-related material, appliance, or device. The most common causes of death and severe injury on construction sites include traffic accidents, events involving on-site vehicles, and the collapse

of materials, all of which cause delays in the completion of the project. Insights from the framework analysis used in the study are what led to the following recommendations for improving worker safety.

- Your company's top executives should set an example by actively engaging in safety meetings and trainings, and everyone should consider safety a top priority.
- Safety councils, which include both management and employees, are one efficient and successful method for enhancing workplace safety. However, if the scope of the work is such that an in-house safety manager is warranted, their salary and benefits should be covered by the budget. As a result, safety becomes embedded in the task itself.
- Your company's top executives should set an example by actively engaging in safety meetings and trainings, and everyone should consider safety a top priority.
- To make sure that proper precautions are taken before work starts, a job safety analysis should be performed for each phase of the project during the planning phase. As part of the project's preparation, it will guarantee safety.
- Educate workers about the dangers, expectations, and precautions associated with using the necessary safety equipment.
- Responsibility for safety and security measures should be assigned across the board, and it should be applied consistently.
- Evaluating a subcontractor's safety record should be a standard element of any procurement procedure. This would include checking the security management system and analyzing the frequency with which OSHA reports are filed. As a result, the workers have taken precautions.
- In order to make the field a safer place, security is checked on a regular basis. Safety concerns from things like old or faulty equipment, risky employee conduct, or misplaced instruments may be identified and addressed before an incident occurs if checks are performed regularly.

- One of the most common ways people get hurt or perhaps die is via falling from great heights. A successful drop protection program relies on a detailed fall management strategy, which should be in place for any project where falls are a possibility.
- Make sure you have drug and alcohol rules in place to prevent people like them from being hired. Substance addiction in the workplace may be prevented in this way.
- During shift changes, weekly meetings, and when switching jobs, make safety a priority. This guarantees that security is constantly discussed.
- The purpose of conducting investigations into all accidents and near-misses is to strengthen safety measures by learning the underlying reasons of these events.

Reducing Communication Gaps

When doing business, the road contractors must take great care in the ways they employ to communicate with one another. Traditional and cutting-edge technology are both at your disposal. In addition, the quality of the information offered necessitates that high-quality communications be broadcast to a sizable body of experts.

Professionals in different fields of construction often need to pool their resources and skills while working together on a project. It is also important to carefully alert prospective clients, consultants, and contractors to such details.

The construction industry as a whole may be negatively impacted by poor communication in a number of ways. It may endanger the project's timeline, money, legalities, quality, and even the safety of its participants.

The following steps should be implemented to enhance coordination on highway and road construction projects.

- Send your communications in a variety of formats to maximize their chances of being understood. Establish a logical command structure and route of communication.

- It is crucial to adopt modern project management software that can effectively interface with any device.
- Implement a system to monitor document changes throughout all project phases and involved parties.
- Use proper grammar, stay away from slang, and make the text simple and easy to read. Whether we're talking about the architects, the contractors, or the construction workers, everyone is worried about the input they get. Regularly check in to see whether the feedback was received and understood on both ends.
- Ongoing instruction in the most effective on- and off-site methods of project management and in the use of all newly acquired hardware, software, applications, security, and regulatory aspects.
- Hiring competent workers and independent contractors makes it simpler and more efficient for everyone on the team to work together.
- Make sure that even in very distant areas, appropriate connections and running networks are accessible.
- Find out whether and how a foreign language is utilized specifically for security and logistics.

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RESUME

Objective:

I want to improve my professional skills and experience within a company who offers perspective and excellence in quality, as well as an environment of confidence and teamwork. To grow with the company in an effective way with the rest of the team offering the best experience in products and services.

Education:

- Bachelor degree Highway and Transportation engineering, AL-Mustansiriyah University.2010/2014
- Master degree of Civil engineering, Istanbul Gedik university.2021/2023

Work Experience:

- I worked as an employee in the office of the dean of AL-Israa University for one year2017.
- Working as civil engineer on following instruments in survey,Road &Transportation and soil in Laboratory in civil Engineering Department for four years at Israa university 2017/2021.
- Working as a member of the Laboratory management committee and Quality Assurance Accreditation Dept,for civil engineering department for three years.
- Worked as civil engineer in D.J. jones constructions Lebanon company for one year.

Volunteer Work:

- Member in Iraqi Engineers Union since 2014.
- Member badn academic.
- Member Minar congress.

Languages:

- Arabic: Native
- English: Advanced.
- Turkish: Good

Skills:

- Microsoft Office Word, Excel, PowerPoint &Access.
- AutoCAD, Revit, ETABS &Primavera.
- Windows Operating system.
- Working with experience of survey engineering instruments: Level, Theodolite, Total station & GPS.
- Working at different properties of Bituminous tests.
- Working with experience of Marshall Mix design pavement.
- Quality Management system ISO 17025 as internal Auditor.
- Working with experience of tests of the soil machine

- Lot of workshops and training courses at civil engineering.
- Research published in Minar congress

Additional:

- Quick learning and efficiency.
- well adapted to environment.
- Staff management.
- Fluency and confidence when talking.